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Genetic Potential of Grapevine in Türkiye

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ABSTRACT: *Grape cultivation and viticulture, have been practiced since ancient times and make grape one of the oldest cultivated fruit species in the world, holding an important place in the social and economic structure of Eastern and Western civilizations in every period. It was determined as a result of archaeological excavations that the origin of Anatolian viticulture dates back to 3500 B.C. Two of the eight gene centers determined by Vavilov in the distribution of plant gene centers around the world (Near East and Mediterranean) intersect on the territory of Türkiye. Our country has a very rich vine genetic potential, both for wild vine (**Vitis vinifera ssp. sylvestris**) and cultivated vine (**V. vinifera ssp. sativa**), which means that Türkiye is the homeland of grapes. Due to its geographical location, Türkiye has ecological conditions that can be considered ideal for the cultivation of table and wine grape varieties. On the basis of research in the field of viticulture, the protection of existing genetic resources and ensuring sustainability should be prioritized. Plant genetic resources are strategic resources for sustainable plant production and are critical to maintaining food security today and in the future. Studies have been carried out by many researchers from the past to the present regarding the identification of grapevine genetic resources available in our country. Studies on determining our grapevine genetic resources started with ampelographic studies and continued with the use of biochemical markers, and today they are continued with the use of DNA markers. In this review, our grapevine genetic resources and their importance are described.*

Keywords: *Vine, viticulture, genetic resource, Türkiye.*

Türkiye'de Asmanın Genetik Potansiyeli

ÖZ: *Çok eski çağlardan beri yetiştiriciliği yapılan asma ve bağcılık kültürü, her dönemde Doğu ve Batı uygarlıklarının sosyal ve ekonomik yapısında önemli bir yer tutan, dünyanın kültürü yapılan en eski meyve türlerinden biridir. Arkeolojik kazılar sonucunda Anadolu bağcılığının kökeninin M.Ö. 3500 yıllarına kadar uzandığı tespit edilmiştir. Vavilov'un bitki gen merkezlerinin dünya üzerindeki dağılımında belirlediği 8 gen merkezinden ikisi (Yakın Doğu ve Akdeniz) Türkiye toprakları üzerinde kesişmektedir. Ülkemiz hem yabani asma (Vitis vinifera ssp. sylvestris) hem de kültür asması (V.vinifera ssp. sativa) için çok zengin bir asma genetik potansiyeline sahiptir. Türkiye, coğrafi konumu nedeniyle sofralık ve şaraplık üzüm çeşitlerinin yetiştirilmesi için ideal sayılabilecek ekolojik koşullara sahiptir. Bağcılık alanındaki araştırmalar temelinde, mevcut genetik kaynakların korunması ve sürdürülebilirliğin sağlanmasına öncelik verilmelidir. Bitki genetik kaynakları, sürdürülebilir bitkisel üretim için stratejik kaynaklardır ve bugün ve gelecekte gıda güvenliğinin sağlanması için kritik öneme sahiptir. Ülkemizde mevcut asma genetik kaynaklarının belirlenmesine yönelik geçmişten günümüze birçok araştırmacı tarafından çalışmalar yürütülmüştür. Asma genetik kaynaklarımızın belirlenmesine yönelik çalışmalar ampleografik çalışmalarla başlamış, biyokimyasal markörlerin kullanımı ile devam etmiş ve günümüzde DNA markörlerinin kullanımı ile sürdürülmektedir. Bu derlemede asma genetik kaynaklarımızdan ve bunların öneminden bahsedilmiştir.*

Anahtar kelimeler: *Asma, bağcılık, genetik kaynak, Türkiye.*

INTRODUCTION

For many years, mankind has considered soil, water and air as the main natural resources, but only recently genetic resources have been added to these. One of the things that makes our Earth unique in the solar system is its genetic resources. Genetic resources contain the genes that direct the development of living organisms. The preservation of genetic resources is not a new idea; the collection and storage of seeds for the next crop year is at least as old as written history. Sumerians came to Anatolia in 2500 BC to collect rose, fig and grape varieties. A record on the walls of the temple of Thebe indicates that in 1495 BC, the queen of Egypt sent her men to Somalia to collect some tree species; these plants were transported in pots along the Nile River and planted in palace gardens. Arabs brought coffee from Abyssinia to Arabia in 900 AD. Later, in the late 16th and early 17th centuries, European explorers identified natural products and plants used by people in the New World and brought them to Europe (Yalçın Dittgen, 2023).

Botanical gardens were established to carry out comprehensive studies on plant species and biodiversity by collecting plants, which are the most valuable assets of our world, from different parts of the world, since ancient times. It is accepted by many authorities that the first botanical garden was established by Aristotle in Athens around 350 BC. The first botanical garden established for educational purposes in the world as it is known today was established in Padua, Italy in 1545 (Figure 1), while it is also claimed that the botanical garden in the city of Pisa in the same country was established two years earlier in 1543 by Luca Gihini. Immediately after the foundation of this garden, other gardens were established in Italy. Jardin Botanique in Paris was established in 1610, Chelsea Physic Garden in London in 1673 and Edinburgh Botanic Garden in 1690 (Demirel *et al*., 2022).

Botanical gardens in Türkiye were first built during the Byzantine and Ottoman Empires for the cultivation of fruits, vegetables, and especially medicinal plants. The first botanical garden in the modern sense was the "Galata Palace Botanical Garden", which was opened in 1839 next to the "Mekteb-i Tıbbiye-i Şahane" building established where Galatasaray High School is located today. Botanical gardens in Türkiye generally operate within universities and prioritise the cultivation and propagation of endemic and rare plants and scientific studies (Müminoğlu *et al*., 2018).

Figure 1. Historic Padua Botanical Garden (Demirel *et al*., 2022).

Şekil 1. Tarihi Padua Botanik Bahçesi (Demirel *et al*., 2022).

Graham *et al*. (2004) defined biological diversity as the differences of ecosystems against variables and the differences of living organisms living in ecosystems among themselves and in their environment. Biological diversity includes genetic diversity expressing the variation within species, species diversity expressing the differences among species and ecosystem diversity formed by living organisms and their physical environment (Atik *et al*., 2010).

The Russian scientist Nikolai I. Vavilov (Figure 2) was the first to foresee the existence and importance of genetic resources and, recognising their contribution to agriculture, travelled to 64 countries collecting plant samples, mostly cultivated varieties. Vavilov is known to have established the first and most advanced genebank of the time by collecting genetic resources and transforming the Bureau of Applied Botany of Tsarist Russia into the Soviet Institute of Applied Botany and Agricultural Plant Institute.

Figure 2. Nikolai I. VAVILOV (Wikipedia, 2023a)
Şekil 2. Nikolai I. VAVILOV (Wikipedia, 2023a)

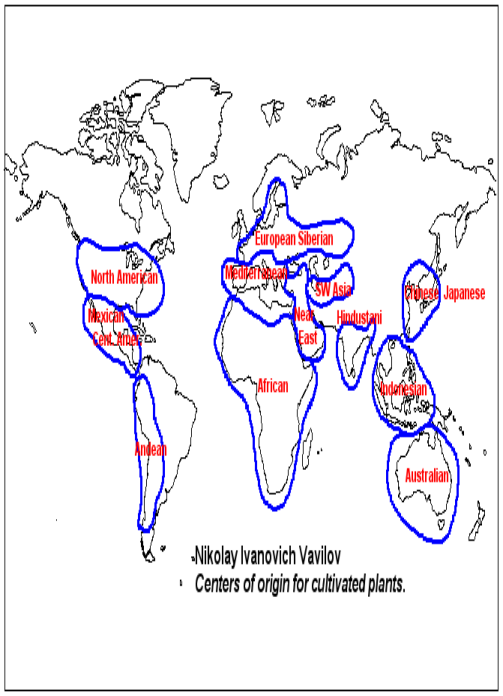

Figure 3. Vavilov, Centre of species (Kloppenburg, 2004).
Şekil 3. Vavilov, Türlerin merkezi (Kloppenburg, 2004).

After the classification of these specimens, the "Centrality of Species View" was put forward, which states that variation within plant species is generally concentrated in small geographical areas and that related forms of cultivated species are found in natural areas. Within the framework of this view, Vavilov named the areas where the plants are cultivated for the first time as "Primary Gene Centres" and the areas where the variation continues after the cultivation of the plants as "Secondary Gene Centres". In addition, Vavilov's definition of the centre of origin of plant genetic resources as "every cultivated plant has been bred in a certain region and all its wild varieties are distributed in that region" clearly indicates the relationship of genetic resources with their natural distribution areas.

After Vavilov, J. Harlan's work on barley, Kuckuck's work on wheat and J. Hawkes' work on potato inspired other plant genetic resource conservators and the richness of plant genetic resources was examined by organising systemic trips (Solberg *et al*., 2023).

Among the centres of origin and diversity described by Vavilov (1951), the Mediterranean and Near Eastern centres overlap in Türkiye (Figure 3) (Kloppenburg, 2004).

Both gene centres have a key role in the emergence of field and horticultural crops such as flax (*Linum*), onion and garlic (*Allium*), barley (*Hordeum*), wheat (*Triticum*), oats (*Avena*), chickpea (*Cicer*), lentil (*Lens*), pea (*Pisum*), sugar beet (*Beta*), grape (*Vitis*), almond (*Amygdalus*) and plum (*Prunus*) (Muminjanov and Karagöz, 2019).

Türkiye is an important gene center for many cultivated plants due to its geographical location and ecological diversity. In other words, Türkiye is the centre of origin or diversity of many important cultivated plants and other plant species. Türkiye is a bridge between continents, a small continent in terms of the biodiversity it hosts (Table 1).

Three of the seven biogeographical regions of the world—the Mediterranean, Euro-Siberian, and Iran-Turan—are found in Türkiye. The fact that Türkiye is located at the intersection of these biogeographical regions has made it valuable in terms of plant biodiversity (Figure 4). The largest forests of cypress, one of the Mediterranean elements, are specified. The Euro-Siberian element consists of Black Sea forests, including alpine meadows. Central Anatolia and Eastern Anatolia steppes are Iran-Turan elements (Muminjanov and Karagöz, 2019).

Table 1. Nine centres of origin identified by Vavilov and genetic resources of agricultural products in these centres (Kloppenburg, 2004).
Çizelge 1. Vavilov'un tanımladığı dokuz orijin merkezi ve bu merkezlerdeki tarımsal ürünlerin genetik kaynakları (Kloppenburg, 2004).

Centres of Origin	Cereals & Legumes	Vegetables & Fruits	Forage Crops	Share of all genetic resource reserves (%)
Africa	Sorghum, millet, coffee	Date Palm	-	4
Mediterranean Region	Canola	Olive, Cabbage, Sugar Beet	-	1.4
Asia Minor/Near East	Wheat, Barley, Mediterranean Rye, Lentil, Common Oats, Broad Bean, Chickpea	Fig, Pomegranate, Apple, Pear, Quince, Cherry, Hawthorn, Grape, Apricot, Walnut	Alfalfa, Persian Triangle, Fenugree Vetch, Vetch, Sainfoin	30
Euro-Siberian	Rye, Oats	-	-	2.4
Australian and North American	Sunflower	-	-	<1
China-Japanese Basin	Soya Beans, Rice	Orange, Tea	-	12.9
Indian	Rice, Indian Hemp	-	-	5.7
Indo-China Subregion	Rice	Banana, Coconut, Yam Sugar, Cane	-	7.5
Latin America	Maize, Cotton, Tobacco	Potato, Tomato, Cassava	-	35

Figure 4. Three bio-geographical region in the world are located in Türkiye (Muminjanov and Karagöz, 2019).
Şekil 4. Türkiye'de yer alan dünyadaki üç biyo-coğrafya bölgesi (Muminjanov and Karagöz, 2019).

According to J. Harlan, there are five micro-gene centres in Türkiye where more than 100 species show wide variation. These centres and common plant species are summarised in Table 2 (Karagöz *et al*., 2010).

Türkiye is also rich in habitat types as a natural consequence of its wide diversity in terms of topography, climate and geomorphological aspects, and this is reflected in the number of plant species and the rate of endemism. The extraordinary ecosystem and habitat diversity also harbours significant species diversity. As a matter of fact, according to Davis (1965-1985) and Davis *et al*. (1988), the total number of our seed plants is 8.745 and 2.763 plant species and one third of this number are endemic. Finally, it was announced that the number of plant taxa in Türkiye has reached 10.754 and 3.708 of them (34.8%) are endemic (İlhan, 2017).

Studies on the collection and utilisation of plant genetic resources in Türkiye started in the first quarter of the 20th century. Turkish scientist Mirza Gökgöl (Figure 5), at a time when the importance of genetic resources was just beginning to be understood in the world, simultaneously with scientists such as Vavilov, Harlan and Zhukovsky, characterised samples collected from all over Türkiye in 1929, 1930, 1935, and 1939, and identified over 18.000 different types and 256 new wheat varieties among them (Karagöz, 2020). Prof. Dr. Osman TOSUN and his colleagues collected a large number of herbarium and seed specimens of cool climate cereals, legumes and oil crops between 1938-1975 (Adak and Akbaba, 1989). The first studies on the fruit species that our country is rich in as a gene source started in 1933 at Ankara University, and the studies focused on hazelnut, apricot, pistachio, fig and grape species for which Anatolia is the gene centre (Ekim, 2005; Atik *et al*., 2010; Anonymous, 2015; Balık, 2017).

Figure 5. Mirza GÖKGÖL (Muminjanov and Karagoz, 2019).
Şekil 5. Mirza GÖKGÖL (Muminjanov and Karagoz, 2019).

Plant genetic resources are a strategic resource for sustainable plant production. Conservation of plant genetic resources is critical to maintain food and nutrition security today and in the future. Genetic resources are insurance for the use of future generations and are also the key to solving urgent agricultural problems (Şakiroğlu, 2010).

Table 2. Micro-gene centres and common species in Türkiye (İlhan, 2017).
Çizelge 2. Türkiye'deki mikro-gen merkezleri ve yaygın türler (İlhan, 2017).

Micro-gene Centre	Species
Thrace-Aegean	Bread wheat, durum wheat, cranesbill wheat, tophead wheat, spa wheat, spelt wheat, coarse grain, melon, lentil, chickpea, common vetch, pigeonpea, clover, trillium.
South-Eastern Anatolia	Hot spring, gernik, *Aegilops speltoides*, gum gourd, watermelon, melon, cucumber, vine, bean, lentil, chickpea, broad bean, fodder crops.
Samsun-Tokat-Amasya	Fruit types and species, beans, lentils, broad beans, legume forage crops
Kayseri and neighbourhood	Apple, almond, pear, fruit species, vine, lentil, chickpea, clover, sainfoin
Ağrı and neighbourhood	Apple, apricot, sour cherry, cherry, melon, legume forage crops

Two main conservation strategies, each consisting of different techniques, are used to preserve genetic diversity *ex-situ* and *in-situ. Ex-situ* conservation means the conservation of components of biodiversity outside their natural habitats. *In-situ* conservation is the conservation of species in their natural habitats and ecosystems where they retain and develop their distinctive characteristics. Ex-situ conservation consists of specialised conservation techniques such as seed genebank, in vitro conservation, cryopreservation and field genebank (Withers and Engels 1990; Engelmann 1997; Maxted *et al*., 1997; Engels and Engelmann, 2002; Anonymous 2014).

Due to the fact that our country has very different climatic conditions, is located in the Near East and Mediterranean Gene Centres, and has five micro-gene centres that are centres of origin, there are wild relatives and local varieties of important fruit species that are cultivated. Türkiye has rich gene resources of wild and cultivated grapevine (Uzun *et al*., 1996; Söylemezoğlu *et al.*, 2001; Uzun and Bayır, 2010; Ergül *et al*., 2011).

Grapevine (*Vitis vinifera* L) is an important species with a very old historical past and widely cultivated economically in the world (Figure 6). According to recent archaeological and archaeobotanical data, grape vine originated in the Neolithic period (ca. 7th-6th millennium BC) in the South Caucasus, located between the Black and Caspian Sea basins. It reached the Iberian Peninsula and Western Europe at the beginning of the Iron Age (ca. 8th century BC) (Harutyunyan and Malfeito-Ferreira, 2022).

Türkiye is one of the important gene centres of the cultivated grapevine *Vitis vinifera* L. ssp. sativa and wild grapevine *Vitis vinifera* ssp. *silvestris* (Arroyo-Garcia *et al*., 2006). *Vitis vinifera* ssp. *Silvestri is known as the ancestor of the cultivated grapevine (Vitis vinifera ssp. sativa) and is, therefore,* an important representative (Çelik *et al*., 1998; Ağaoğlu, 1999; Ağaoğlu, 2002; Çelik *et al*., 2005).

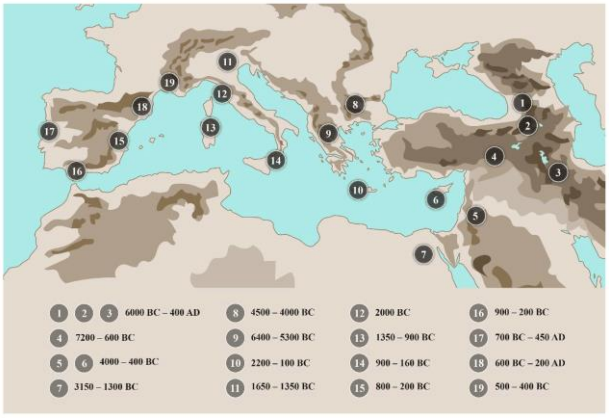

Figure 6. The distribution map of the earliest evidences of viticulture (Harutyunyan and Malfeito-Ferreira, 2022).

Şekil 6. Bağcılığın en eski kanıtlarının dağılım haritası (Harutyunyan and Malfeito-Ferreira, 2022).

Many ampelographers, archaeologists, botanists and grapevine geneticists state that the first findings of viticulture and wine production were in the Eastern and Southeastern Anatolia region of Türkiye between the Tigris and Euphrates Rivers, known as the Mesopotamian lands, between western Iran and the Caucasus Mountains (Vouillamoz *et al*., 2006; Özdemir and Karataş, 2008).

The Fertile Crescent consists of a crescent-shaped area dominated by the Mediterranean climate with rainy winters and dry summers. The Fertile Crescent is the region that covers the Eastern Mediterranean and parts of present-day Jordan, Israel, Iraq, Syria, Iran and Southeastern Anatolia and provides the most favourable conditions for life. The western end of this region reaches as far as Çatalhöyük, located within the borders of Çumra district of Konya province (Figure 7). According to some scientists, most of The Fertile Crescent, one of the three main regions where agriculture emerged simultaneously, is within Anatolian territory (Schumann, 1972; Pasternak, 1998; McGovern, 2003; Arroyo-Garcia *et al*., 2006; This *et al*., 2006).

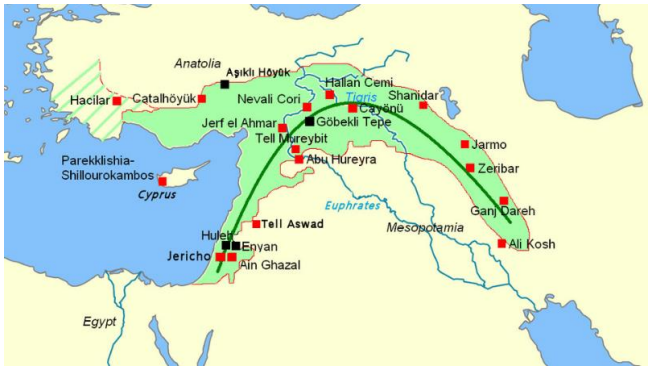

Figure 7. Soils from which the first findings related to viticulture and winemaking originated (Wikipedia, 2023b).

Şekil 7. Bağcılık ve şarapçılıkla ilgili ilk bulguların ortaya çıktığı topraklar (Wikipedia, 2023b).

The diversity of today's grapevine populations is a result of the history of mankind. Vavilov (1951), argues that before the origin of plants can be determined, the places where they were cultivated must be taken into account. Accordingly, it was emphasised that the place where any plant species shows the most change is its birth centre (Fidan, 1985; Karataş and Karataş, 2018). Based on this richness, the most comprehensive study on the collection and conservation of grapevine genetic resources of Türkiye was the project titled "Determination, Conservation and Identification of Grapevine Genetic Resources of Türkiye" which started to be carried out by the Republic of Türkiye Ministry of Agriculture and Forestry Tekirdağ Viticulture Research Institute in 1965. Project activities have been carried out so far by liaising with Provincial Directorates of Food, Agriculture and Livestock, relevant departments/academicians of universities and directly with producers. As a result of the inventory studies carried out in the first years, it was determined that there are approximately 1.600 grape varieties in our country, and today, 1.435 varieties are preserved in the National Collection Vineyard (Uysal and Yaşasın, 2017).

Characterisation studies carried out in vineyard genetic resources first started with ampelographic identification studies. Morphological descriptions were made with universal identification criteria by looking at the generative-vegetative organs of the varieties such as flowers, berries, seeds, shoots and leaves. After the developments in agricultural biotechnology, the use of molecular marker techniques came to the forefront. Nowadays, molecular marker techniques are used to characterise plant genetic resources at the gene level and both methods are complementary to each other (İşçi and Altındişli, 2017).

Nowadays, the field genebanks in 18 research institutes within the Republic of Türkiye Ministry of Agriculture and Forestry General Directorate of Agricultural Research and Policies (TAGEM) have shared the responsibility for the conservation of fruit-vine genetic resources in accordance with the ecology in which they are located. The responsibility is in three different forms: primary, secondary and regional conservation. The research organisations responsible for the conservation of fruit-vine genetic resources in Türkiye are given in Table 3.

In Türkiye, 62% of the fruit and vine genetic material stored in land genebanks has characterisation information. Grapevine genetic resources are the species for which the most characterisation and evaluation studies have been carried out. When examined according to fruit groups, it is seen that grape ranks first with a rate of 28% (Aykas *et al*., 2018). Tekirdağ Viticulture Research Institute, which is primarily responsible for the conservation of grapevine genetic resources in Türkiye, is the research institute that conserves the most grapevine genetic resources with a total of 1.539 materials, 1.435 of which are local types and 104 of which are of foreign origin. Republic of Türkiye Ministry of Agriculture and Forestry Manisa Viticulture Research Institute and Pistachio Research Institute follow with 1.231 and 112, respectively.

Table 3. Research institutions responsible for the conservation of fruit and vineyard genetic resources in Türkiye and area of field genebanks (da)
Çizelge 3. Türkiye meyve-bağ genetik kaynaklarının muhafazasından sorumlu araştırma kuruluşları ve arazi gen bankası alanları (da) (Aykas *et al*., 2018).

Institutions	Responsible for conservation at first degree	Responsible for conservation at second degree	Responsible for conservation at the regional level	Area of Field Genebanks (da)
Alata Horticultural Research Institute, Mersin	Banana, carob	Apricot, pomegranate, almond, fig, citrus, new world, pecan, avocado	Olive	206.0
Pistachio Research Institute, Gaziantep	Pistachio		Cherry, almond, walnut, olive, vine	125.0
Atatürk Horticultural Central Research Institute, Yalova	Peach-Nectarine, cherry, apple, pear, walnut, grape fruits, jujube	Chestnut, cranberry	Olive	104.0
West Mediterranean Agricultural Research Institute, Antalya	Citrus, loquat, avocado	Carob	Pomegranate, olive, persimmon	100.0
East Mediterranean Transitional Zone Agricultural Research of Institute, Kahramanmaraş	-	Grape Fruits	Vine	92.0
Aegean Agricultural Research Institute, İzmir	Plum, cherry, quince, pomegranate, almond, chestnut	Peach, jujube	Kocayemiş	92.0
Eğirdir Fruit Research Institute, Isparta	-	Plum, cherry, cherry, apple, pear, quince	-	78.0
Erzincan Horticultural Research Institute, Erzincan	Rosehip	Walnut, mulberry	Apricot, cherry, cherry, plum, peach, apple, pear, quince, vine, almond	60.0
Hazelnut Research Institute, Giresun	Hazelnut, Blackcurrant	Persimmon	-	40.0
GAP International Agricultural Research And Training Center, Diyarbakır	-	-	Almonds, figs	40.0
Transitional Zone Agricultural Research Institute, Eskişehir	-	-	Cherry	38.2
Fig Research Institute, Aydın	Fig	-	-	28.3
Black Sea Agricultural Research Institute, Samsun	Persimmon, huckleberry	-	Cherry, sour cherry, apple, chestnut, mahlep, black cherry	20.9
Apricot Research Institute, Malatya	Apricot, mulberry, mulberry, cranberry, hawthorn, buckthorn	-	Cherry, vine	20.6
Manisa Viticulture Research Institute, Manisa	-	Vine	-	9.0
Middle Black Sea Transitional Zone Agricultural Research Institute, Tokat	-	-	Apple, pear, cherry, plum, vine	8.0
Tekirdağ Viticulture Research Institute, Tekirdağ	Vine	-	-	6.0
Olive Research Institute, İzmir	Olive	-	-	3.5

The activities of the project titled "Determination, Conservation and Identification of Grapevine Genetic Resources of Türkiye" are summarised below in chronological order.

In 1965, the project was started and inventory studies were carried out until 1969.

Land preparation and rootstock planting were started in 1970-1971.

In 1970-1971, land preparation and rootstock planting were started. Tekirdağ and Çanakkale vineyard fields in the Thrace region of the Marmara Region were visited and varieties were identified.

In 1974, surveys were started in the Aegean, Marmara, Thrace and Western Black Sea regions and 421 varieties were identified and 303 of them were brought to the Institution.

In 1975-1976, 108 grape varieties were identified in the Eastern Black Sea Region and 193 in the Mediterranean Region.

In 1977, 164 grape varieties were identified in the Central Anatolia Region.

In 1979, South Eastern Anatolia Region surveys were started.

In 1981, 977 varieties were identified and 791 varieties were grafted.

In 1982, efforts were made to complete the missing varieties in Tekirdağ and Çanakkale provinces. Ampelography studies were started in grape varieties/types that have reached the yielding age.

In 1983, grape varieties were labelled in Kahramanmaraş, Gaziantep, Adıyaman, Urfa, Mardin, Siirt, Diyarbakır, Kırklareli and Edirne provinces. The ampelographic characteristics of grape varieties/types belonging to Bursa and Balıkesir provinces were started to be extracted.

In 1984, 126 local grape varieties were identified by travelling to Istanbul, Kocaeli, Çankırı, Yozgat, Sivas, Erzincan, Tunceli, Elazığ, Malatya and Kayseri provinces. The ampelographic characteristics of the varieties/types of Çanakkale and Bilecik provinces were started to be determined.

In 1985, the ampelographic characteristics of 52 grape varieties/types belonging to Çanakkale, Edirne, Kastamonu, Sinop and Sakarya provinces were started to be extracted. The missing varieties were completed by travelling to Kocaeli province.

In 1986, ampelographic characteristics of 55 grape varieties/types belonging to Ankara, Sakarya, Çanakkale, Manisa and Denizli provinces were started to be determined and their pictures were taken.

In 1987, ampelographic characteristics of 56 grape varieties/types belonging to Denizli, Muğla and Ankara provinces were started to be prepared.

In 1988, the ampelographic characteristics of 73 grape varieties/types belonging to Afyon, Kütahya, Muğla and Ankara provinces were started to be determined. Until this year, 58 provinces were visited and 1.253 grape varieties were identified.

In 1989, ampelographic characteristics of 84 grape varieties/types belonging to Konya, Çanakkale, Artvin, Rize, Eskişehir and Gümüşhane provinces were started to be determined.

Until 1990, ampelographies of 409 varieties were completed. The ampelographic characteristics of 41 grape varieties belonging to Antalya, Isparta, Burdur, Ankara and Çanakkale provinces were started to be determined. At the 5th International Viticulture Symposium held in Germany, the ampelography method was accepted and the transition from UPOV to OIV was made.

In 1991, ampelographic characteristics of 41 grape varieties/types belonging to Antalya, Isparta, Burdur, Bolu, Çanakkale and Zonguldak provinces were started to be extracted.

In 1992, the ampelographic characteristics of 43 grape varieties/types from Antalya, Kocaeli, Kırşehir and Zonguldak provinces were determined according to the OIV method. Herbarium of 89 cultivars examined in previous years was made. Varieties were transported to Ankara, Tokat, Erzincan, Kars and Erzurum provinces and stocks were purchased. Until this year, 534 varieties were examined, 409 varieties were ampelographed according to the old method and 125 varieties according to OIV.

In 1993, the ampelographic characteristics of 49 grape varieties belonging to Antalya, Edirne, Kırklareli and

Adana provinces were determined according to the OIV method. Ampelography of 583 cultivars was completed in total.

In 1994, the ampelographic characteristics of 29 grape varieties of Adana and Hatay provinces were determined according to the OIV method. The ampelography of a total of 612 varieties was completed. In 1995, the ampelographic characteristics of 43 grape varieties/types belonging to Adana and Hatay provinces were determined according to the OIV method. The ampelography of a total of 655 varieties was completed.

In 1996, ampelography of a total of 857 varieties, 409 UPOV and 448 OIV, was completed.

In 1997, the ampelographic characteristics of 187 grape varieties/types belonging to Çankırı, Kayseri, Ankara, Sivas, Tokat, Adıyaman, Çanakkale, Denizli, Edirne, Kırşehir, Manisa, Erzincan, Muğla, Tekirdağ, Balıkesir, Yozgat, Çorum, Malatya, Mardin and Bursa provinces were determined.

In order to renew the existing collection vineyard in 1998-2000, preparations were made for the vineyard where 450 varieties would be established and the ampelographic characteristics of the provinces continued to be determined.

In 2001, the extraction of ampelographic characteristics continued.

In 2002, a total of 398 varieties were transferred to the new collection vineyard, and the illustrations and descriptions of the varieties continued.

In 2003, with the newly transferred varieties, the total number of transferred varieties was 859. Among the varieties that could not be collected before, 7 from Diyarbakır, 7 from Bitlis, 11 from Van, 7 from Karabük and 4 grape varieties from Bartın were identified.

In 2004, stocks of the varieties identified in the previous year were taken and grafted seedlings were produced. Efforts were made to eliminate the deficiencies in identification.

In 2005-2006, a total of 60 grapevine varieties were identified in the Çoruh Valley, stocks were taken in the first months of 2006 and grafted seedlings were produced. The identification work was carried out to eliminate the deficiencies.

In 2007, a duplicate vineyard was established in the same institution by completing the deficiencies in the newly established collection vineyard.

In 2008, 46 new grape types were identified in Muğla province. "Sample Catalogue of Grapevine Genetic Resources of Türkiye" was prepared and the interim final report of the project was completed. The establishment of a Biotechnology Laboratory for molecular identification was initiated.

In 2008-2009, the Türkiye Grapevine Collection Linkage was completed, the values taken throughout the years were studied, and the interim final report of the project was written. "Türkiye Grapevine Genetic Resources Catalogue" was prepared and brought to the printing stage (Boz *et al*., 2012).

As the characterisation and evaluation studies carried out in fruit and grapevine genetic resources increase, the use of materials with superior characteristics stored in field genebanks in breeding also increased. With the characterisation studies carried out in vineyard genetic resources, the existing genetic diversity of our country and foreign origin is revealed by using ampelographic traits or biochemical markers.

In Türkiye, ampelographic studies were started for the first time in 1926 by Ahmet Hamdi. He analysed the viticulture of Ankara province and the ampelographic characteristics of grape varieties grown in this region according to Moog (1930) (Çelik and Karanis, 1998).

The main objectives of the studies carried out for the identification of grapevine gene resources are the conservation of the gene resource and its utilisation in breeding studies. In addition to the ampelography studies carried out for many years to reveal the grapevine gene potential and to identify grape varieties suitable for different evaluation purposes from the existing population, there are identification studies at isoenzyme level. However, due to the inadequacies of both ampelographic parameters and enzymatic discriminations, and the fact that ampelographic characteristics are affected by environmental conditions and vine age, the use of

DNA markers that can provide fast and effective results has been started in recent years (; Çetiner, 1981; Gönülşen, 1986; Ağaoğlu and Ergül, 1999; Tan, 2010; Şehirali and Özgen, 2012; Yılmaz *et al*., 2012; Kaplan and Sayal, 2013; Özgen *et al*., 2015; Anonymous, 2017; Aykas *et al*., 2018; Karagöz *et al*., 2020).

Among the genetic resources that reflect both the climatic and geographical characteristics of the region where they are located, local varieties that continue to be cultivated from ancient times to the present day are very important. The importance of plant gene resources is better understood day by day. Studies should be increased in order to prevent the loss and utilisation of these resources (Adıgüzel and Solmaz, 2023). As a result of the researches and studies carried out in research institutions, most of which are affiliated to the General Directorate of Agricultural Research, and some of which are carried out in the relevant faculties of universities, collection and selection, and partially clone selection studies have been completed in many species and varieties. Ampelographic studies have also been completed in the National Collection vineyard. Today, the development of plant biotechnology has provided significant advantages in terms of plant genetic resources. As a result of the studies and researches at DNA level, genetic relationships and genetic linkages of some cultivars and type groups were determined at the level of different markers. In Türkiye, many studies have been carried out using DNA markers to determine grapevine genetic resources (Ergül *et al*., 2011).

A total of 48 grape varieties (*Vitis vinifera* L.), including 35 cultivars grown in Gaziantep province, 11 cultivars transferred from this province to Tekirdağ National Collection Vineyard and 2 reference cultivars, were genetically identified by allele profiles at the genetic level using 17 microsatellite markers and genetic similarity between them was investigated. Two main groups emerged in the dendrogram. Many sub-groups were observed in the first group, which included most of the genotypes. Among the genotypes, "Dusuzu" and "Dımışkı" varieties from Gaziantep province were found to be synonyms. Again, 5 homonyms were found except for Rumi varieties from Tekirdağ and Gaziantep provinces. A close similarity rate was observed between "Kış üzümü" and "Sergi Karası", "Sarı Kabarcık" and "Serpenekıran" varieties from Gaziantep. It is thought that these have the same genotype and may be possible somaclonal variants (Karaağaç, 2006).

There are many local grape varieties that are still widely cultivated in some regions of Türkiye. One of these regions is the Eastern Mediterranean Region, and in order to identify the grapevine gene resources of the region, genetic analyses of 59 grape varieties were carried out using 14 SSR primers. As a result of the study, it was determined that the genetic relationships among the varieties were not related to their ecogeographic distribution within the region. Among the cultivars analysed in the study, the cultivars with the same genotype (synonymy) or with the same name but different genotype characteristics (homonymy) were identified. This study, which presented the first genetic analysis results of the grapevine genotypes of the region, supports more efficient use of gene resources and breeding programmes (Tangolar *et al*., 2008).

It has been observed that there is variety confusion due to different nomenclature and intra-variety variations, and some old grape varieties that are not used in cultivation are facing the risk of gradual disappearance. In order to reduce these problems, the viticultural potential of Manisa, İzmir, Aydın, Muğla provinces and Kütahya province located in the Central Anatolian transition zone of the region was identified by using SSR's (Simple Sequence Repeats) markers. In the research carried out by using 15 SSR markers in 55 grape varieties including 53 local and 2 reference varieties, while no similar and synonymous genotypes were found, 5 homonyms were detected in "Tek Çekirdekli", "Bulama", "Beyaz Şam", "Ekşi Üzüm" and "Sıksarı" genotypes. The findings obtained in this research will shed light for other identification studies when the same SSR loci are used and the results of the research will contribute to other viticulture activities (breeding, propagation, variety registration, etc.) to be carried out in the region (Yüksel, 2008).

Türkiye, located in one of the most favourable climatic zones of the globe for viticulture, has a very old and deep-rooted viticulture culture and is the gene centre of the grapevine. The climate of Eskişehir province is primarily suitable for wine grape cultivation, while Kayseri province stands out with its table and seeded dried grape cultivation. As a part of the identification of our national grapevine gene

resources at the level of SSR markers, genetic identification of a total of 41 grape varieties, including 25 varieties belonging to the province of Eskişehir in the Central North agricultural region and 14 grape varieties and 2 reference varieties belonging to the province of Kayseri in the Central South agricultural region, was carried out by SSR technique and the genetic parameters and identities of the varieties belonging to these two provinces were determined based on SSR markers. Among the 15 SSR loci used, 14 primers provided sufficient discrimination between cultivars, but due to the high rate of null allele suspicion at the VRG1 locus, the dendrogram was formed with 14 loci; 4 synonymous and 1 homonymous cultivars were identified (Shidfar, 2008).

Although the climate of Ankara and Çankırı provinces is primarily suitable for the cultivation of wine grape varieties, it is a growing area where the interest in table grape cultivation has gradually increased with the irrigation facilities developed in recent years. In one study, a total of 51 grape varieties (*Vitis vinifera* L.), including 49 varieties and 2 reference varieties transferred from Ankara and Çankırı provinces to Tekirdağ National Collection Vineyard, were genetically identified using 15 microsatellite markers. Among the genotypes, 2 identical genotypes, 4 synonyms and 5 homonyms were found. The results of this research obtained by using SSR markers are a first for the identification of grape gene resources of both Ankara and Çankırı provinces and Central Anatolia Region by using SSR technique (Yıldırım, 2008).

The Mediterranean Region has very favourable ecological conditions for early table grape varieties in terms of climate and ranks second after the Aegean Region in terms of production and area. In another study, the genetic identities of 53 grape varieties (*Vitis vinifera* L.), including 50 varieties and 3 reference varieties transferred from the Western Mediterranean Region, Antalya and Mersin provinces to Tekirdağ National Collection Vineyard, were determined using 20 microsatellite markers. The total number of alleles at the 20 loci used was determined as 166. Among the genotypes, 4 homonyms, 3 synonyms and 1 homonym group were found. The genetic findings found as a result of the research were included in the "Turkey Grapevine Gene Resources Database" which is being created as a result of the institutional project of "Ankara University Biotechnology Institute" (TUBITAK- KAMAG group, Project no: 105G078) and related by comparing them with each other. The results of this research obtained by using SSR markers are a first for the identification of grape gene resources of both Antalya and Mersin provinces and the Mediterranean Region. The results of this research are important for better identification of the varieties in the National Collection, regulation of the number of varieties in the national collection and breeding studies (Aslantaş, 2010).

Molecular characterisation of 56 Kara (Black) grape varieties collected from 32 provinces in Türkiye and transferred to Tekirdağ National Collection Vineyard was carried out with 20 SSR loci. At the end of the study, two similar, four synonymous and five homonymous varieties were found and the total number of Kara (Black) grape varieties was determined as fifty. The genetic findings of the research were included in the "Turkey Grapevine Gene Resources Database" and related by comparing them with each other. The findings obtained in this research, which is the first to be carried out for the identification of black grape varieties at SSR level, will shed light on other studies to be carried out in the future (Yıldırım, 2010).

In the study of Dilli *et al*. (2011), molecular screening of six Gemre grape varieties [“Dumanlı Gemre (1)”, “D. Gemre (2)”, “Gökçe G”., “Halis G”., “Black G”., “Sultani G”.] and “Pink G”. clones selected in Manisa Viticulture Research Institute and a total of eleven *Vitis vinifera* L. grape varieties using two varieties as reference were carried out with the help of 15 microsatellite markers. As a result of the study, the molecular difference of Gemre accessions was revealed. It was observed that the varieties subject to the study have similar names but different genetic characters (homonym).

In another study, the relationship between wild grapevine and cultivated grapevine gene resources in the Southeastern Anatolia Region was revealed by SSR molecular markers. For this purpose, 22 nuclear and 3 chloroplast microsatellite loci were analysed on 21 wild grapevine (*Vitis vinifera* ssp. silvestris) and 13 cultivated grapevine (*Vitis vinifera* ssp. sativa) genotypes. The number of alleles for SSR loci ranged from 4 (VVIn16) to 20 (VVIv67). The expected heterozygote ratio at the loci studied ranged from 0.586 (locus VVIb01) to 0.876 (locus VVS2). Three

chloroplast cpSSR markers were also analysed in the studied genotypes. Allele sizes for chloroplast SSR markers were cpSSR3 (106 and 107 bp), cpSSR5 (104 and 105 bp), and cpSSR10 (114, 115, and 116 bp), respectively. For wild grapevine genotypes, 7 alleles were grouped under 3 haplotypes (B, C and D). According to the results of microsatellite analysis, the dendrogram showed that wild and cultivated grapevines were not genetically similar (Karataş, 2013).

Genetic diversity in 36 local grapevine cultivars and 2 standard cultivars ("C. Sauvignon" and "Merlot") cultivated in the Aegean region was analysed by SSR markers. The use of 11 SSR primers showed favourable amplifications and the formation of 37 polymorphic bands was observed. The molecular difference between the local cultivars and the cultivars used as reference was clearly observed. "Siyah Razakı" and Parmak" varieties showed the highest similarity with 0.96. Synonymity was determined in "İnek Memesi" and "Ufak Dimrit" varieties. In addition, homonymy was detected in the varieties. The findings prove that SSR markers can be used as an effective method in genetic differentiation researches by fingerprinting in grapevines (İşçi and Dilli, 2014).

In order to investigate the genetic diversity of Turkish grapes, 22 nuclear and 3 chloroplast microsatellites were used and 21 wild *Vitis vinifera* L. ssp. sylvestris and 13 cultivated vines (*Vitis vinifera* ssp. sativa types) were evaluated. As a result of the research, Southeastern Anatolia Turkish grapes were divided into 4 main branches. The study grouped the majority of Elazığ grapes (e.g. "Öküzgözü") in group 1, while most of Diyarbakır grapes (e.g. "Boğazkere") were grouped in group 2th the majority of the wild varieties included in the study were in groups 3th and 4th "Cabernet Sauvignon" and "Merlot" varieties used as reference varieties were in the 4th group. The results also showed a clear distinction of wild varieties within Turkish genetics (Karataş *et al*., 2014).

Genetic characterisation studies have an important place for the determination of genetic diversity both within and between species and for the identification of species. Within the grapevine genetic resources, which contain very rich local varieties and types grown almost everywhere in Türkiye, variety confusion has been observed as a result of naming differences and variations in varieties, and there is also a danger of extinction of some varieties that are not currently preferred in production. In one study, which was carried out as a part of the determination of grape varieties and types in the grapevine genetic resources in the Southeastern Anatolia Region, genetic identification of 50 grape varieties and types in Mardin, Siirt and Şırnak provinces of the Southeastern Anatolia Region was carried out using 6 SSR loci. A total of 46 alleles were detected on 6 loci. When the genetic relationship dendrogram was analysed, the reference cultivars showed an independent branching from the genotypes within the scope of the study, and 3 synonym groups were found within the existing 2 branches. In the light of the data obtained in this study, it will be possible to determine the number of different varieties in the national collection (Aslan, 2018).

In other research, it was aimed to determine the genetic affinities of "Şika", "Sultan1", "Sultan7", "Razakı", "Akhisar Razakısı", and "Mevlana" grape varieties from Manisa Viticulture Research Institute collection vineyards with 14 ISSR primers. Usable bands were obtained from 10 of the 14 primers and 77 bands were found to be polymorphic. According to Euclidian Distance Matrix, the closest varieties were found to be "Razakı" and "Mevlana", and the farthest varieties were found to be Mevlana-Sultan1. According to the genetic similarity matrix obtained by using Simple Matching Similarity Coefficient, it was found that the most similar samples were "Razakı" and "Sultan1" (0.779), and the most distant samples were "Şika" and "Sultan7" and "Şika" and "Mevlana".

It is known that grapevine, one of the oldest cultivated plants on earth, has more than 10000 varieties in the world and therefore it is very important to identify the plant correctly with homonyms and synonyms in grapevine cultivation (Aşık, 2019).

It is very important to preserve grapevine genetic resources in Turkish collection vineyards, determine their ampelographic characteristics, reveal genetic profiles with molecular marker methods and create a data bank. In the research carried out between 2017 and 2018 in order to comprehensively examine the local types/varieties cultivated in Eskişehir Province and to identify the identified grape varieties using SSR markers from molecular methods, genetic identification of 52 grape varieties/types identified in different districts of Eskişehir Province was carried out with 18 SSR primers. A total of 171 alleles were obtained as a result of genetic analyses of 52 grape varieties whose ampelographic characteristics were

determined and 1 reference variety with 18 SSR loci, while the highest number of alleles was determined at the ZAG79 locus with 14 and the average number of alleles was determined as 9.5. As a result of the study, 1 synonym and 4 homonyms were determined (Baykul and Söylemezoğlu, 2023).

As a result of studies on the identification of grape genotypes by SSR markers, it has been suggested that the genetic diversity in Türkiye is higher in wild species compared to cultivated species (Ergül *et al*., 2011; Karataş *et al*., 2014). The genetic diversity of wild species in Türkiye was found to be higher than that of wild species in Iran, Morocco and France (Karataş *et al*., 2014). From these results, the prediction of a serious decrease in the number of populations as a result of intraspecific hybridisation of wild grape varieties started to lose its validity with the detection of rare alleles in the study of Ergül *et al*. (2011). It is known that analyses of wild species in eastern countries such as Iran, Georgia and Türkiye, where grape breeding was first carried out, are of great importance in understanding the historical grape breeding process and wild species can be used as new gene sources (Karataş *et al*., 2014).

CONCLUSIONS

Türkiye, located at the intersection of three bio-geographical regions, namely Euro-Siberian, Iran-Turan and Mediterranean, has a very rich plant biodiversity. Türkiye is located at the intersection of the Near Eastern and Mediterranean gene centres and has five micro-gene centres that offer a wide variation in plant species. These micro-gene centres are grouped as Thrace and Aegean, South and Southeast Anatolia, Samsun-Tokat and Amasya provinces, Ağrı province and its surroundings, Kayseri province and its surroundings. The micro-gene centre of species such as almond, apple, pear, lentil, chickpea, alfalfa, sainfoin and grapevine (*Vitis vinifera* L.) was determined as Kayseri province and its surroundings (Anonymous, 2019).

The project studies were carried out by liaising with Provincial Directorates of Food, Agriculture and Livestock, relevant departments/ academicians of universities and directly with producers. As a result of the inventory studies carried out in the first years, it was determined that there are approximately 1.600 grape varieties in our country, and today, 1.435 varieties are preserved in the National collection vineyard (Uysal and Yaşasın, 2017).

The decrease in biodiversity has reached dangerous dimensions due to industrialisation, fossil fuel use, urbanisation pressure, natural disasters, especially climate change, for which mankind is responsible. In this context, the rich biodiversity of Türkiye should be utilised as an important mechanism for breeding grape varieties tolerant to biotic and abiotic stress conditions and as well as climate change. Most molecular marker techniques are used in the assessment of genetic diversity and the construction of genetic-physical maps. Thus, studies on molecular characterisation of conserved genetic resources in grapevine collection vineyards in Republic of Türkiye Ministry of Agriculture and Forestry Tekirdağ and Manisa Viticulture Research Institute and the other responsible for conservation at the regional level to vine have great importance (Table 3). Moleculer data of the Turkish Vitis Collection will contribute to the Vitis International Variety Catalogue (database), JKI, Julius Kühn-Institut.

In addition to grapevine field genebanks other conservation methods such as cryopreservation should be applied. Cryopreservation method should be used as a complementary method to the field genebanks by establishing a grapevine cryobank. In this way, conservation will be guaranteed by protecting the material from environmental conditions such as drought, floods, pests, and diseases. In addition, an increase in the numbers of research institutions, researchers and research support related to biodiversity will enhance the conservation and utilization as grapevine.

REFERENCES

Adak, M. S., and G. Akbaba. 1989. Gıda günlüğü. Osman Tosun Gen Bankası. Bilim ve Teknik 28-29.

Adıgüzel, P., and İ. Solmaz. 2023. Türkiye'de bitki genetik kaynaklarının mevcut durumu ve korunması. Turkish Journal of Agricultural Research 10(3): 352-360.

Ağaoğlu, Y. S. 1999. Bilimsel ve Uygulamalı Bağcılık (Cilt l): Asma Biyolojisi. Kavaklıdere Eğitim Yayınları, Ankara.

Ağaoğlu, Y. S. 2002. Bilimsel ve Uygulamalı Bağcılık (Cilt 2): Asma Fizyolojisi. Kavaklıdere Eğitim Yayınları, Ankara.

Ağaoğlu, Y. S., and A. Ergül. 1999. Amasya üzüm çeşidi ekotiplerinin RAPD markörler ile genetik tanımlanmaları. Türkiye III. Ulusal Bahçe Bitkileri Kongresi, Ankara Üniversitesi Basımevi, Ankara.

Anonymous. 2014. Genebank standards for plant genetic resources for food and agriculture. FAO E-ISBN 978-92-5-108262-1 5: 65-109.

Anonymous. 2015. Çölleşme/Arazi bozulumu ve kuraklıkla mücadele terimler sözlüğü. https://www.tarim orman.gov.tr/CEM/Belgeler/collesme%20belgeleri%20arsiv/Sayfa02/CollesmeSozluk.pdf (access date: 22.04.2022)

Anonymous. 2017. Dökümantasyon Projesi. Türkiye arazi gen bankası veri tabanı kayıtları. Ege Tarımsal Araştırma Enstitüsü.

Anonymous. 2019. Türkiye'nin biyoçeşitliliği: genetik kaynakların sürdürülebilir tarım ve gıda sistemlerine katkısı. Ankara. 222s. Licence: CC BY-NC-SA 3.0 IGO.

Arroyo-Garcia, R., Ruiz-Garcia, L., and L. Bolling. 2006. Mültiple origins of cultivated grapevine (*Vitis vinifera* L. ssp. *sativa*) based on chloroplast DNA polymorphisms. Moi. Ecoi., 15: 3707-3714.

Aslan, K. A. 2018. Mardin, Siirt, Şırnak illerine ait asma gen kaynaklarının SSR'a dayalı genetik karakterizasyonu. Yüksek Lisans Tezi. Harran Üniversitesi Fen Bilimleri Enstitüsü.

Aslantaş, Ş. 2010. Batı Akdeniz üzüm çeşitlerinin moleküler karakterizasyonu ve ülke asma kaynakları ile genetik ilişkisi. Yüksek Lisans Tezi. Ankara Üniversitesi Biyoteknoloji Enstitüsü, Ankara.

Aşık, M. 2019. Manisa ili'nde yetiştirilen Mevlana, Razakı, Sultani Çekirdeksiz ve Şika üzüm çeşitlerinin bazı ampelografik özellikleri ve ISSR markırları ile tanımlanması. Yüksek Lisans Tezi. Celal Bayar Üniversitesi Fen Bilimleri Enstitüsü, Tarımsal Bilimler Anabilim Dalı, Manisa.

Atik, A. D., M. Öztekin, and F. Erkoç. 2010. Biyoçeşitlilik ve Türkiye'deki endemik bitkilere örnekler. Gazi University Journal of Gazi Educational Faculty (GUJGEF) 30(1).

Aykas, L., G. Kafa, M. Uzun, A. Doğan, M. Özdemir, R. Uğur, E. Küçük, T. Seymen, H. Vurgun, H.İ. Balık, M. Çiçek, Ş. Sarıçam, A. Ayar, İ. Macit, N. Gültekin, M. Kesgin, K. Özyurt, T. Uysal ve H. Kaya. 2018. Türkiye arazi gen bankaları. ANADOLU Ege Tarımsal Araştırma Enstitüsü Dergisi 28 (2): 76-87.

Balık, H. İ. 2017. Biyolojik çeşitlilik ve genetik kaynaklar araştırmaları eğitim sunusu. 52 slayt.

Baykul, A. ve G. Söylemezoğlu. 2023. Eskişehir ilinde yetiştirilen üzüm çeşitlerinin SSR markörler ile tanımlanması. Bahçe 52 (Özel Sayı 1): 18–23.

Boz, Y., T. Uysal, A. S. Yaşasın, A. Gündüz, G. G. Avcı, , M. Sağlam, T. Kıran ve L. Öztürk. 2012. Türkiye asma genetik kaynakları. Tekirdağ Bağcılık Araştırma İstasyonu. T.C. Gıda Tarım ve Hayvancılık Bakanlığı Tarımsal Araştırmalar ve Politikalar Genel Müdürlüğü.

Çelik, H., Y. S. Ağaoğlu, Y. Fidan, B. Marasalı ve G. Söylemezoğlu. 1998. Genel Bağcılık. Sunfıdan A.Ş., Mesleki Kitaplar Serisi: l, Fersa Matbaacılık San. ve Tic. Ltd. Şti., Ankara.

Çelik, H. ve C. Karanis. 1998. Amasya yöresinde yetiştirilen bazı üzüm çeşitlerinin ampelografik özelliklerinin saptanması üzerine bir araştırma. IV. Bağcılık Sempozyumu, Yalova.

Çelik, S., E. Bahar, İ. Korkutal ve K. Demir. 2005. Türkiye'de doğal olarak yetişen yabani asmanın (*V. vinifera* ssp. *silvestris*) tanımlanması ve üretimde kullanılabilme olanakları üzerine araştırma. Türkiye 6. Bağcılık Sempozyumu. 19-23 Eylü 2005. Tekirdağ. s. 22-31.

Çetiner, E. 1981. Türkiye Bitki Genetik Kaynakları Meyve ve Bağ Envanteri. Ege Böl. Zir. Ara. Ens. Yay. No. 19. Menemen.

Demirel, Ö., M. B. Bingöl Bulut, and T. G. Aydoğan. 2022. A review on botanic gardens. Biodiversity Studies (BiSt) 1(2): 75-83. https://doi.org/10.56494/ dnbgt.2022.10.

Dilli, Y. ve A. Altındişli. 2011. Gemre çeşitleriyle Pembe Gemre klonlarının SSR markörlerle moleküler ve ampelografik özelliklerinin karşılaştırılması. Türkiye VI. Ulusal Bahçe Bitkileri Kongresi. 4-8 Ekim 2011. Şanlıurfa.

Ekim, T. 2005. Türkiye'nin Biyolojik Zenginlikleri. Türkiye Çevre Vakfı Yayınları, Yayın No: 170. Önder Matbaası. Ankara.

Engelmann, F. 1997. Importance of desiccation for the cryopreservation of recalcitrant seed and vegetatively propagated species. Plant Genetic Resources, Newsletter 112: 9-18.

Engelmann, F. 2000. Importance of cryopreservation for the conservation of plant genetic resources. pp. 8-20. In: F. Engelmann, and H. Takagi (Eds.). Cryopreservation of Tropical Plant Germplasm-Current Research Progress and Applications. JIRCAS, Tsukuba, Japan, & IPGRI, Rome. Italy.

Engels, J. M. M., and F. Engelmann. 2002. Botanic gardens and agricultural genebanks: Building on complementary strengths for more effective global conservation of plant genetic resources. Plant Gene. Resour. Newslett. 131: 49-54.

Ergül, A., G. Perez-Rivera, G. Söylemezoğlu, K. Kazan, and R. Arroyo-Garcia. 2011. Genetic diversity in Anatolian wild grapes (*Vitis vinifera* subsp. sylvestris) estimated by SSR markers. Plant Genetic Resources: Characterization and Utilization, 9(3): 375–383.

Fidan, Y., 1985. Özel Bağcılık. Ankara Üniversitesi Ziraat Fakültesi Yayınları, Yayın No: 930, Ankara.

Graham, L. E., J. M. Graham, and L.W. Wilcox. 2004. Bitki Biyolojisi. Çeviri Editörü: Kani Işık, Ankara: Palme Yayınları.

Harutyunyan, M., and M. Malfeito-Ferreira. 2022. The rise of wine among ancient civilizations across the Mediterranean basin. Heritage 5(2): 788-812. https://doi.org/10.3390/ heritage5020043.

İlhan, D. 2017. Bitki biyoteknolojisinde genetik kaynakların önemi. Kafkas Üniversitesi Fen Bilimleri Enstitüsü Dergisi 10(2): 134-144.

İşçi, B., and A. Altındişli. 2017. Ampelographic characterizatıon of Turkish indigenous grape accessions and European cultivars (*Vitis vinifera* L.). Int. J. Agric. Environ. Food Sci., 1: 1-16.

İşçi, B., and Y. Dilli, 2014. Characterization of autochthonous grapevine cultivars (*Vitis vinifera* L.) from the Aegean region of Turkey using Simple Sequence Repeats (SSRs). The Journal of Agricultural Sciences (JAS) 21: 538-545.

Kaplan, N. ve B. Sayal. 2013. Bahçe bitkileri araştırmalarının geçmişi, bugünü ve geleceği. Bahçe Haber 2(2).

Karaağaç, E. 2006. Gaziantep ili asma gen potansiyelinin SSR (Simple Sequence Repeats) markörlerle moleküler analizi. Yüksek Lisans Tezi.Ankara Üniversitesi Fen Bilimleri Enstitüsü, Ankara.

Karagöz, A. 2020. Mirza Gökgöl: Plant scientist, seed collector, agronomist, breeder and archaeo-botanist. Ekin Journal of Crop Breeding and Genetics 6 (1): 1-10.

Karagöz, A., N. Zencirci, A. Tan, T., Taşkın, , H., Köksel, M. Sürek, C. Toker ve K. Özbek. 2010. Bitki genetik kaynaklarının korunması ve kullanımı. Türkiye Ziraat Mühendisliği VII. Teknik Kongresi. 1: 155-177.

Karataş, D. D. 2013. Türkiye'nin Güneydoğu Anadolu bölgesi yabani asma (*Vitis vinifera* ssp. silvestris) ve kültür asması (*Vitis vinifera* ssp. sativa) genotipleri arasında genetik akrabalık ilişkilerinin belirlenmesi. Selçuk Journal of Agriculture and Food Sciences. 27.

Karataş, D. D. ve H. Karataş. 2018. Diyarbakır ili asma gen potansiyeli. BAHÇE 47 (Özel Sayı 1: Türkiye 9. Bağcılık ve Teknolojileri Sempozyumu) 173-178.

Karataş, D. D., H. Karataş, V. Laucou, G. Sarıkamış, L. Riahi, R. Bacilieri, and P. This. 2014. Genetic diversity of wild and cultivated grapevine accessions from Southeast Turkey. Hereditas 151 (4-5): 73-80.

Kloppenburg, J. R. 2004. First The Seed: The policital economy of plant biotechnology. 1492-2000. University of Wisconsin Pr. Kloppenburg J.R. AGE.

Maxted, N., B. V. Ford-Lloyd, and J. G. Hawkes. 1997. Complementary conservation strategies. pp. 15-39 In: N. Maxted, B.V. Ford-Lloyd and J. G. Hawkes (Eds.). Plant Genetic Resources Conservation. Chapman & Hall, London.

McGovern, P. E. 2003. Ancient Wine: The Search of the Origin of the Viniculture. Princeton University Press. New Jersey.

Moog, H. 1930. Beitrage zur Ampelographie. Buchdruckerei Arthur Jander, Geisenheim.

Muminjanov, H. ve A. Karagöz. 2019. Türkiye'nin Biyoçeşitliliği: Genetik Kaynakların Sürdürülebilir Tarım ve Gıda Sistemlerine Katkısı. Birleşmiş Milletler Gıda ve Tarım Örgütü, Ankara 2019.

Müminoğlu, Y., B. Tahta Türkyılmaz ve B. G. Aslan. 2018. Kentsel yaşama bilimsel, görsel, rekreasyonel katkılar; botanik bahçeleri. MSU J. of Sci. 6(1): 519-528. doi: 10.18586/msufbd.

Özdemir, G. ve H. Karataş. 2008. Diyarbakır ili bağcılığı. Ulusal Bağcılık-Şarap Sempozyumu ve Sergisi. 6-8 Kasım 2008. Denizli. s. 405-413.

Özgen, A., M. Murat, S. Adak, H. Ulukan, B. Benlioğlu, M Peşkircioğlu,. N. Koyuncu, A. Yıldız ve D. A. Tuna. 2015. İklim değişikliği ve bitkisel gen kaynakları. TMMOB Ziraat Mühendisliği Odası Türkiye Ziraat Mühendisliği VIII. Teknik Kongresi. 12-16 Ocak 2015. Bildiriler Kitabı.

Pasternak, R. 1998. Investigations of Botanical remains from Nevali cori PPNB, Turkey. pp. 170-177. In: A. Damania, J. Valkoun, G. Willcox, *et al*. (Eds). The Origins of Agriculture and Crop Domestication. ICARDA, Syria.

Schumann, E. 1972. Notes on the occurrence of wild grapes in Turkey. Notizen zum Vorkommen von Wildreben in der Tuerkei. Wein-Wiss., 32: 169-173.

Shidfar, M. 2008. Eskişehir ve Kayseri illeri asma gen kaynaklarının SSRs (Simple Sequence Repeats)'a dayalı genetik karakterizasyonu. Yüksek Lisans Tezi. Ankara Üniversitesi Fen Bilimleri Enstitüsü, Ankara.

Solberg, S. Ø., G. I. Loskutov, L. Breian, and A. Diederichsen. 2023. The impact of N.I. Vavilov on the conservation and use of plant genetic resources in Scandinavia: A review. Plants 12: 143. https://doi.org/ 10.3390/plants12010143.

Söylemezoğlu, G., Y. S. Ağaoğlu, and H. I. Uzun. 2001. Ampelographic characteristics and isozymic analysis of *Vitis vinifera* ssp. *silvestris* Gmel. in Southwestern Turkey. J. Biotechnol. 2: 106-113.

Şakiroğlu, M. 2010. Bitki genetik kaynaklarının uluslararası paylaşım sorunu. Seta Analiz (25): 6-13.

Şehirali, S. ve M. Özgen. 2012. Bitki Genetik Kaynakları. Ankara Üniv. Ziraat Fak. Yayınları No: 1020. Ders Kitabı: 294, Ankara.

Tan, A. 2010. Türkiye bitki genetik kaynakları ve muhafazası. Anadolu J. of AARI 20(1): 9-37.

Tangolar, S. G., S. Soydam, M. Bakır, E. Karaağaç, S. Tangolar, and A. Ergül. 2008. Genetic analysis of grapevine cultivars from the Eastern Mediterranean region of Turkey, based on SSR Markers. Tarım Bilimleri Dergisi 15(1): 1-8.

This, P., T. Lacombe, and M. R. Thomas. 2006. Historical origins and genetic diversity of wine grapes. Trend Genet. 22 (9): 511-519.

Uysal, T. ve A. S. Yaşasın. 2017. Asma genetik kaynaklarımız ve Nevşehir ili üzüm çeşitleri. Nevşehir Bilim ve Teknoloji Dergisi (Kapadokya Ulusal Bağcılık Çalıştayı Özel Sayı) 6: 132-136.

Uzun, I. H., and A. Bayir. 2010. Distribution of wild and cultivated grapes in Turkey. Notulae Scientia. Biologicae 2 (4): 83-87.

Uzun, İ., Y. S. Ağaoğlu, and G. Söylemezoğlu. 1996. Distribution and isozymic analysis of wild grapevines (*Vitis vinifera* SSP. *silvestris* Gmel.) in Turkey. International Symposium on in situ Conservation of Plant Genetic Resources. Central Res. Ins. for Field Crops. Ankara.

Vavilov, N. I. 1951. The origin, variation, ımmunity and breeding of cultivated plants. pp. 293-350. The Chronica Botanica. Cambridge, UK.

Vouillamoz, J. F., P. McGovern, A. Ergül, G. Söylemezoğlu, G. Tevzadze, C.P. Meredith, and S. M. Grando. 2006. Genetic characterization and relationship of traditional grape cultivars from Transcaucasia and Anatolia. Plant Genet Resour. 4: 144-158.

Wikipedia. 2023a. Nikolai Vavilov. wikipedia.org.

Wikipedia. 2023b. The Fertile Crescent. wikipedia.org.

Withers, L. A., and J. M. M. Engels. 1990. The test tube genebank -a safe alternative to field conservation. IBPGR Newsletter for Asia and the Pacific 3: 1-2.

Yalçın Dittgen, J. B. 2023. Instruments of ancient Mesopotamian and Anatolian culture. Çukurova Üniversitesi Sosyal Bilimler Enstitüsü Dergisi (ÇÜSBED) 32(1): 227-237. https://dergipark.org.tr/tr/pub/cusosbil.

Yıldırım, F. 2008. Ankara ve Çankırı illeri asma gen kaynaklarının SSRs (Simple Sequence Repeats)'a dayalı genetik karakterizasyonu. Yüksek Lisans Tezi Ankara Üniversitesi Fen Bilimleri Enstitüsü, Ankara.

Yıldırım, N. 2010. Kara (Siyah) üzüm gruplarının SSR (Simple Sequence Repeat) markörlere dayalı karakterizasyonu ve ülke asma kaynakları ile genetik ilişkisi. Yüksek Lisans Tezi. Ankara Üniversitesi Biyoteknoloji Enstitüsü, Ankara.

Yılmaz, N., T. Alas, and K. Abak, 2012. Collection of local vegetables genotypes with their wild relatives in North Cyprus, Acta Hort. (ISHS), 960: 135-138.

Yüksel, C. 2008. Manisa, İzmir, Aydın, Muğla ve Kütahya illerine ait asma gen kaynaklarının SSRs (Simple Sequence Repeats)'a dayalı genetik karakterizasyonu. Yüksek Lisans Tezi. Ankara Üniversitesi Biyoteknoloji Enstitüsü, Ankara.