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Diversity and Distribution of Almonds in their Center of Origin

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Abstract

Almond (*Prunus dulcis*; Syn. Amygdalus communis) is one of the most widely cultivated nuts in the world. Almond has several wild types, including more than 30 species. It has been reported that these species were adapted and distributed to the increasingly xerophytic environments of Central and Southwest Asia. Iran is the world's most important gene pool for wild almonds. So far, 23 species and 7 of their interspecies hybrids have been reported in Iran. These species are distributed in different habitats of Iran, some of which are endemic. Therefore, without any doubt, almonds originated and were probably domesticated in this area and then spread to other areas.

Keywords: Prunus; Biodiversity; Bioclimatic requirements; Phytogeographical region; Euro-siberian; Irano-anatolian; Saharo-sindian

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Introduction

Iran is located in the Palaearctic realm and is considered the center of origin for many plant genetic resources (germplasms) in the world [1]. It is estimated by Iranian botanists that there are as many as 8,000 species which, 18% of them are endemic [2]. Iran was a center for the evolution of many agricultural crops. The people engaged in agriculture settled there about 10,000 years ago [1]. Iran is located in the Middle East. Since Iran spans a wide range of latitudes and longitudes, it also has a diverse range of physiography, climate, vegetation, and biological productivity. Approximately 90% of the country, generally classified as a mountainous and semi-arid area, is situated on the Iranian Plateau (Irano-Afghan plate). Iran's natural conditions and geographical position are in the intersection of three phytogeographical regions, including

a) Pontic (Euro-Siberian) region consisting of the Hyrcanian zone and Arasbaranian zone

b) Irano-Anatolian (Turco-Iranian) region, which includes the Zagrosian zone and Irano-Touranian zone

c) Nubo-Syndian and Saharo-Sindian region, which includes Khalidjo-Omanian zone

The Hyrcanian zone consists of the humid Caspian forests of northern Iran. The Arasbaranian zone consists of semi-humid forests in the marginal southwest of the Caspian Sea. The Zagrosian zone includes semi-arid forest. The Irano-Turanian zone is known as dry and desert forests. This region is the largest geographical region in Iran and consists of two parts, the plain and mountains. The Khalidjo-Omanian zone consists of subtropical dry forests in the south of the country, including a strip north of the Persian Gulf and the Gulf of Oman [3]. Almond (*Prunus dulcis*, Syn. Amygdalus communis) is one of the most widely cultivated nuts in the world (Figure 1). Almond is probably one of the early fruit trees that was domesticated in old-world agriculture [4]. Nowadays, it is widely cultivated in the Mediterranean basin [5] and represents the largest production of any commercial tree nut product in the world [6].

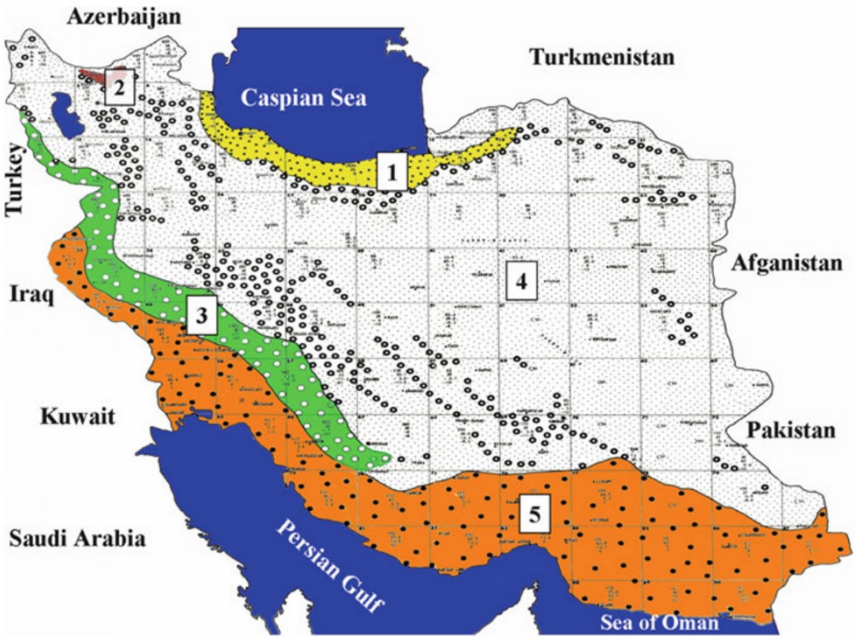

Figure 1: Phytogeographical regions of Iran (Euxino-Hyrcanian: 1 Caspian (Hyrcanian), 2 Arasbaran; Irano-Turanian: 3 Zagros, 4 Steppic central plateau, 5 Saharo-Sindian) [25].

Almond needs special bioclimatic requirements for growth. Regions characterized by a more or less rainy but relatively mild winter combined with a warm, rainless spring and summer have proven best for almond growth. Cool, rainy weather during blossom time may limit production by reducing insect pollen transfer and increasing the development of fungus diseases. Almond has several wild types, including more than 30 species. It is reported that the almond species were adapted to the increasingly xerophytic environments of Central and Southwest Asia [5,6]. Spach [7] divided the Amygdalus sub-genus into almond and peach groups; he organized the 22 almond species into 5 sections: Euamygdalus, Spartioides, Lycioides, Chameamygdalus, and Leptopus. In 1996, Browicz and Zohary classified the 26 almond species in the Amygdalus genus and divided this genus into two sub-genus (Amygdalus and Dodecandra) (Table 1). In one of the newest classifications of wild almond species [8], the almonds consisted of 24 species, which are grouped under the Prunus genus and a sub-genus, Amygdalus. This sub-genus contains two series Icosandrae and Dodecandrae (Figure 1). Iran is the world's most important gene pool for wild almonds. Zohary [9] described that the almonds distributed in Iran throughout the Turco-Iranian area. Iran and Anatolia were the centers in which its various species evolved and from which they were diffused. So far, 23 species and 7 of their interspecies hybrids have been reported in Iran by Sabeti [10], Javanshir [11], Ghahreman [12], Siami [13], Khatamsaz [14], Mobayyen [15], Mozaffarian [16], Attar [17]. Furthermore, some specimens have not been identified yet [18,19]. These species are distributed to various biogeographical regions of Iran, some of which are endemic. In fact, Iran is situated in 3 massive growth regions, which are the Caspian flora, Balooch flora, and Irano–Turanian flora. No wild species of almonds have been reported in the Hyrcanian zone. The Arasbaranian zone consists of three wild species of almonds. The Zagrosian zone includes the most variety of wild almond species, and so far, 21 wild almond species have been reported in this zone. The Irano-Turanian zone consists of 17 wild almond species. The Khalidjo-Omanian zone includes six wild almond species [11]. The distribution of wild almond species has been studied in these regions. The Irano-Turanian and Zagrosian Flora are very well characterized by the frequency and richness of species of the genus Amygdalus, especially the region of Zagros, consisting mainly of Amygdalus spp. In some areas above 2,600-meter elevation, the only trees capable of surviving are Amygdalus and Juniperus genus [11]. In the first classifications of Iranian wild almonds, almond species were classified based on the thorn characteristics of their branches, petiole length, and leaf blade shape and size [10]. Wild almond species in different ecological regions pose very large variations in their leaf sizes and pubescences, which make their classification very hard and sometimes impossible. Therefore it has been suggested that nut characteristics should also be considered for better wild almond classification [14]. Some of the wild stands of almonds occurred near population centers, and important trade routes, such as the Silk Road that connected central Asia with China, passed through wild almond groves (Table 2). It was suggested that Amygdalus communis spread from Iran, Caucasia, and South of Turkey to Syria, Lebanon, and Jordan [20] and then was spread to Italy, France, Spain, Portugal, Tunisia, and Morocco and was sent to North America [6]. Perhaps some almonds from Persia accompanied Alexander the Great's minions home to Greece [21]. Almond is scattered and settled down toward the east to China, India [22] and Turkmenistan, Uzbekistan, Afghanistan, Pakistan, Tajikistan, Kyrgyzistan, and Kazakhstan.

Table 1: Wild almonds' habitat regions in Iran [11].

Arid and Subtropical Forests (Khalidjo-Omanian)	Arid and Desert Forests (Irano-Touranian)	Semi-Arid Forests (Zagrosian)	Semi-Humid Forests (Arassbaranian)	Humid Forests (Hyrcanian)
P. spartioides	*P. communis*	*P. communis*	*P. communis*	n/a
P. scoparia	*P. trichamygdalus*	*P. glauca*	*P. kotschyi*	
P. podperae	*P. arabica*	*P. arabica*	*P. horrida*	
P. eburnea	*P. scoparia*	*P. scoparia*		
P. horrida	*P. keredjensis*	*P. podperae*		
P. wendelboi	*P. podperae*	*P. fenzliana*		
	P. fenzliana	*P. orientalis*		
	P. urumiensis	*P. urumiensis*		
	P. kotschyi	*P. carduchorum*		
	P. eburnea	*P. kotschyi*		
	P. lycioides	*P. eburnea*		
	P. erioclada	*P. lycioides*		
	P. haussknechtii	*P. erioclada*		
	P. elaeagnifolia	*P. haussknechtii*		
	P. horrida	*P. elaeagnifolia*		
	P. leiocarpa	*P. horrida*		
	P. turcomanica	*P. leiocarpa*		
		P. ulmifolia		
		P. kurdistanica		
		P. ghahremani		
		P. orazii		

Table 2: Distribution of almond species in Iran based on the altitude [14,16,17].

Scientific Name	Distribution above Sea Level (m)	Situation
Prunus brahuica Boiss.	2700-3800	
P. carduchorum Bornm.	1200-2000	
P. communis L.	800-1700	
P. eburnea Spach.	200-2500	Endemic
P. elaeagnifolia subsp. elaeagnifolia	1700-3000	Endemic
P. elaeagnifolia subsp. leiocarpa (Boiss.) Browicz.	1100-3400	Endemic
P. erioclada Bornm.	2150	
P. fenzliana (Fritsch) Lipsky	1250-1800	
P. ghahremani	1500	
P. glauca Browicz.	2000	Endemic
P. hausskenchtii (C.K. Schneider) Bornm.	1300-3100	Endemic
P. korshinski (Hand-Mazz.) Bornm.	1300-1600	
P. kotschyi Boiss. & Hohen	1800-2000	Endemic
P. kurdistanica	1675	
P. lycioides var. horrida (Spach.) Browicz.	1100-2200	Endemic
P. lycioides var. lycioides	250-2350	
P. nairica Fed. Et Takht.	1100-2200	
P. orazii	1650	
P. orientalis Duh.	1600-2500	
P. reticulata Runemark ex Khatamsaz.	1650-1900	Endemic
P. scoparia Spach.	300-3100	
P. spartioides Oliv.	1000-1500	

P. spinosissima subsp. spinosissima	1200-1900	
P. spinosissima subsp. turcomanica (Linez.) Browicz.	800-2000	
P. trichamygdalus (Hand-Mazz.) Woronow.	500-1750	
P. wendelboi Freitag.	1800	Endemic
P. × iranshahri Khatamsaz	700	Endemic
P. × kamiaranesis Khatamsaz.	1300-1400	Endemic
P. × keredjensis Browicz	1350-1800	Endemic
P. × mozaffariani Khatamsaz.	2300-2900	Endemic
P. × pabotii Browiez	1350-1850	Endemic
P. × podperae Woroon	1500	Endemic
P. × yasujensi Khatamsaz.	2000	Endemic

Discussion

Almond has more than 30 species. It has been reported that the origin of almonds is central and western Asia [5,6], but Browics [23] suggested that almonds may have originated in the Levant area and not in central Asia as previously reported. So far, 23 species and 7 of their interspecies hybrids have been reported in Iran. These species are distributed in different habitats of Iran, some of which are endemic. Therefore, without any doubt, almonds originated and were probably domesticated in this area and then spread to other areas. Iran has several phytogeographical regions. The Hyrcanian zone consists of the humid Caspian forests of northern Iran. No wild species of almonds have been reported in this region. The Arasbaranian zone consists of semi-humid forests in the marginal southwest of the Caspian Sea. Three wild species of almonds have been reported in this region [24,25]. The Zagrosian zone includes semi-arid forests and has the most variety of wild almond species. So far 21 wild almond species have been reported in this zone. The Irano-Turanian zone is known as dry and desert forests. This region is the largest geographical region in Iran and consists of two parts, the plain and mountains, and 17 wild almond species have been reported in this zone. The Khalidjo-Omanian zone consists of subtropical dry forests in the south of the country, including a strip north of the Persian Gulf and the Gulf of Oman. Six wild almond species have been reported in this zone [10,11].

Conclusion

So far, 23 species and 7 of their interspecies hybrids have been reported in Iran. These species are distributed in different habitats of Iran, some of which are endemic. Therefore, without any doubt, almonds originated and were probably domesticated in this area and then spread to other areas.

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