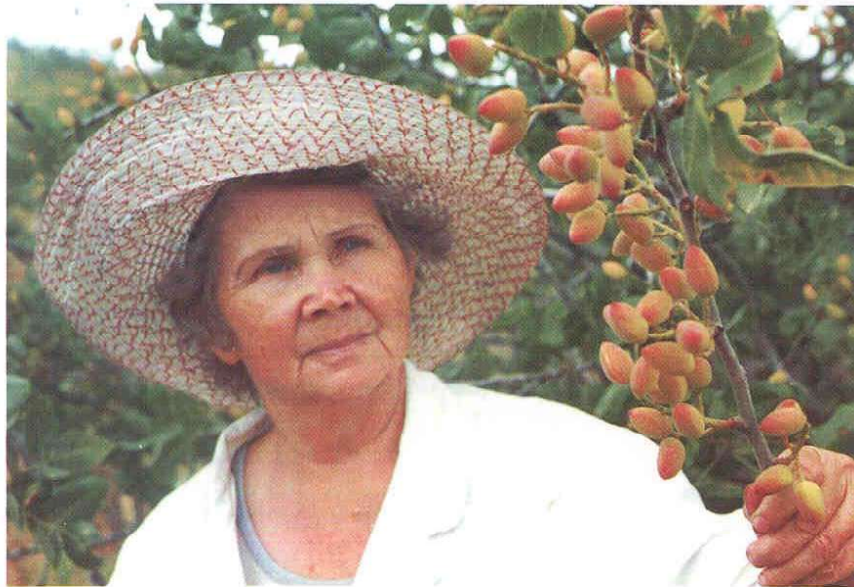




Towards a comprehensive documentation and use of *Pistacia* genetic diversity in Central and West Asia, North Africa and Europe

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Pistachio production and cultivated varieties grown in Turkey

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Introduction

Turkey is one of the main pistachio nut producing countries in the world. Pistachio (*Pistacia vera* L.) is the only edible crop among the 11 species of the genus *Pistacia* (Ak 1998a). It grows in limited areas due to its ecological requirements. Pistachio has been growing in wild or semi-wild forms for hundred of years in areas of Afghanistan, Northwest India, Iran, Turkey, Syria and other Near East and North African countries. The taxonomy of pistachio is as follows (Bilgen 1973).

Division	Phanergamae
Sub-division	Angiospermae
Class	Dicotyledoneae
Sub-class	Choripetales
Order	Sapindales
Family	Anacardiaceae
Genus	<i>Pistacia</i>
Species	<i>Pistacia vera</i>

Pistachio is a dioecious fruit tree; male and female flowers are in fact produced on different trees and pollination is by wind. For this reason male trees should be present in the orchards. These are planted generally at the ratio of one male to eight (or 11) female trees. Pistachio trees can be grown in steppe or semi-desert areas where winters are cold and summers are long, dry and hot with annual precipitation varying between 150 and 300 mm (Ak 1992, Kaşka 1990).

The non-bearing period length, the more or less alternate bearing habit, fruit quality, blank nut formation and blooming time are the main characters that are of interest in each cultivar. These traits should be considered when deciding the most suitable cultivar structure for each production area (Valls 1990).

World pistachio production

The world production over four consecutive years is given in Table 1. The main world producers of pistachio nuts are Iran, USA, Turkey and Syria. Commercial exploitation of pistachio commenced in the 1930s in Iran, which still remains the largest producer (Chang 1990), providing 56.10% of the world's production. The second largest pistachio producer is USA, where Kerman is the most commonly grown cultivar. It covers over 90% of the total country production of pistachios. In both Iran and USA, pistachio plantations are irrigated whereas in Turkey there is no irrigation yet in place for this crop.

Table 1. World pistachio production (tons)

Countries	Years				Average	%
	1994	1995	1996	1997		
Iran	210 000	239 000	282 000	111 916	210 729.0	56.10
USA	58 100	67 130	47 630	81 650	63 627.5	16.93
Turkey	35 000	51 000	42 000	60 000	47 000.0	12.51
China	24 500	25 000	25 000	28 000	25 625.0	6.82
Syria	15 000	14 500	18 000	29 428	19 232.0	5.12
Greece	4 200	4 000	4 350	5 000	4 387.5	1.17
Italy	200	2 000	2 000	3 000	1 800.0	0.48
Afghanistan	1 900	1 600	1 600	1 600	1 675.0	0.45
Tunisia	1 000	900	1 000	1 150	1 012.5	0.27
Pakistan	300	200	200	200	225.00	0.06
Jordan	30	30	30	30	30.00	0.01
Cyprus	30	25	20	33	27.00	0.01
Others	--	325	325	325	243.80	0.06
World	350 260	405 710	424 155	322 332	375 614.3	100.00

Source: FAO Production Yearbook for 1994, 1995, 1996 and 1997

Pistachio production in Turkey

Pistachio has been cultivated for thousands of years in Turkey. It is speculated that Anatolia is one of the locations where pistachio might have originated.

Pistachio orchards are established in two ways: (1) through the top working of wild pistachio shrubs, trees and their hybrids which are used as rootstocks and which grow mainly in Anatolia. Under dry and non-irrigated conditions, a new pistachio orchard takes about 20-25 years to bear economic nut yields. This could be shortened to five to seven years by top working the wild trees. (2) By sowing the seeds directly using seedlings. As mentioned previously, pistachio production areas are characterized by dry and hot summer climates. Rainfall is very low and there is no irrigation or rain during the summer period. Therefore seedlings require a very long period to reach the budding stage (eight to ten years) (Kaşka 1990).

Pistachio can grow in very marginal soils, such as those that are stony, calcareous and poor. Pistachio in fact can be grown in soils, which are unsuitable for other crops. Pistachio productions in Turkey from 1994 to 1997 are given in Table 1. Table 2 provides estimates on the number of trees and yield in Turkey from 1955 to 1996. The numbers of trees were 6.5 million in 1955, but this value reached to 44 million in 1996 with 54% of bearing trees. That means that the production is expected to increase in the future when non-bearing trees will enter production. The total production of nuts was 7636 tons in 1955 and reached 60 000 tons in 1996. There is no stability of production across years because of alternate bearing of trees. Although the yield per tree is very low, the production as a whole is increasing each year.

The reasons behind the low yields in Turkey are: (i) young trees start bearing fruit very late, (ii) yield is very low on young trees, (iii) the soils of pistachio orchards are very poor, (iv) annual precipitation is very low and irrigation facilities do not exist, (v) application of chemical fertilizer is very limited, (vi) pollination is inefficient, (vii) most of the varieties have strong alternate bearing (Kaşka 1990, Ak 1998b). Out of these constraints, the most limiting factors in pistachio yields are irrigation, pollination and alternate bearing. Research efforts to address these problems are on-going in Turkey and elsewhere.

Pistachio is intensively grown in Şanlıurfa, Gaziantep and Adıyaman areas (Table 3). Most of the pistachio cultivation areas are situated to the southern part of Turkey.

Table 2. Pistachio production and number of trees in Turkey

Years	Number of trees (×1000)			Production (Tons)	Index* yield	Yield (kg/tree)
	Total	Bearing	Non-bearing			
1955	6 579	--	--	7 636	100.00	1.16
1960	8 413	--	--	11 900	156.00	1.41
1965	10 750	--	--	8 170	107.00	0.76
1970	18 123	10 937	7 186	14 200	186.00	1.30
1975	24 400	14 000	10 400	31 000	406.00	2.21
1980	28 150	16 150	12 000	7 500	98.00	0.46
1981	28 900	17 400	11 500	25 000	327.00	1.44
1982	30 330	17 400	12 930	13 000	170.00	0.75
1983	30 230	17 400	12 830	25 000	327.00	1.44
1984	30 600	17 600	13 000	23 000	301.00	1.31
1985	31 495	18 100	13 395	35 000	458.00	1.93
1986	30 310	18 640	12 670	30 000	393.00	1.61
1987	32 692	18 977	13 715	30 000	393.00	1.58
1988	33 377	19 343	14 034	15 000	196.00	0.78
1989	37 007	20 067	16 940	40 000	524.00	0.50
1990	37 418	20 385	17 033	14 000	183.00	0.69
1991	36 673	21 080	15 793	64 000	838.00	3.04
1992	38 600	22 000	16 600	29 000	380.00	1.32
1993	40 831	22 948	17 883	50 000	655.00	2.18
1994	41 689	23 340	18 349	40 000	524.00	1.71
1995	42 760	23 850	18 910	36 000	471.00	1.51
1996	44 080	24 480	19 600	60 000	786.00	2.45

Source: Agricultural Structure and Production (statistics), State Institute of Statistics, Turkey.

*Estimated on the basis of number of bearing tree only.

Table 3. Main pistachio producer areas in Turkey

Provinces	Number of trees ¹			Production ²		Yield ³
	Total	Bearing	%	Tons	%	
ŞANLIURFA	14 845 660	8 125 210	54.73	21 439.8	46.11	2.64
GAZİANTEP	14 838 800	9 162 500	61.75	12 377.0	26.62	1.35
ADİYAMAN	5 490 300	3 305 000	60.20	3 817.5	8.21	1.16
K.MARAŞ	1 415 000	799 000	56.47	2 467.5	5.31	3.09
SİİRT	1 140 100	558 700	49.00	1 311.5	2.82	2.35
DİYARBAKIR	195 900	83 575	42.66	710.00	1.53	8.50
ÇANAKKALE	339 710	280 040	82.44	567.80	1.22	2.03
BATMAN	174 370	56 300	32.29	540.30	1.16	9.60
MARDİN	598 996	156 150	26.07	522.50	1.12	3.35
MANİSA	796 511	409 211	51.38	462.30	0.99	1.13
İZMİR	312 320	160 290	51.32	421.30	0.91	2.63
AYDIN	363 780	144 180	39.63	381.50	0.82	2.65
TOTAL	40 511 447	23 240 156	57.37	45 019	96.82	1.94
OTHERS	3 568 553	1 239 844	34.74	1 481	3.18	1.19
TURKEY	44 080 000	24 480 000	55.54	46 500	100.00	1.90

¹Source: State Institute of Statistics (1996 data), Turkey.

²Average of 4 years (1993-1996).

³Estimated on the basis of number of bearing trees only.

As Table 3 indicates the main producer areas are those of Southern Anatolia. This region includes the GAP locality (Southern Anatolia Project), which is a major regional development effort. Thanks to the GAP project in the near future most of those listed areas

will have irrigation facilities. The first three main producer cities meet about 81% of total pistachio production in Turkey (Table 3).

Pistachio varieties grown in Turkey

In Turkey, there are eight main domestic varieties, viz. Uzun, Kırmızı, Halebi, Siirt, Beyazben, Sultani, Değirmi and Keten Gömleği (Table 4); and five foreign varieties, viz. Ohadi, Bilgen, Vahidi, Sefidi and Mümtaz (Table 5). For some varieties proper characterization using IPGRI's descriptors for pistachio (*Pistacia vera* L.) has been carried out (Barone *et al.* 1997).

Diversity of Turkish varieties

Following some values of most relevant descriptors for pistachio Turkish varieties are provided. Reference to IPGRI's descriptor list codes for *Pistacia vera* is given in parentheses whenever applicable.

1. Habit (6.1.2): Tree habits vary from erect to semi-erect, Halebi variety being the only erect type.
2. Flowering: Flowering period is very important because of the danger of late spring frost. Generally pistachio tree inflorescences appear late if we refer to other fruit species. Among the domestic varieties, Halebi and Değirmi are early flowering; Kırmızı, Uzun, Beyazben and Sultani are mid-early and Siirt variety has intermediate.
3. Fruiting rachis: Changed from dense to sparse.
4. Ripening period: Early nut ripening is very important in pistachio as late fruit maturation could encounter rain and this would result in high production losses. In Turkey fruits are harvested by hand and this is a time-consuming operation. Fruits are spread on canvas to dry. Generally, early varieties mature at the beginning of September, having enough time to let fruits dry under the sun. However even early varieties are harvested late in some years. If late ripening occurs, the split nut rate will be low.
5. Bearing (6.3.10): All Turkish varieties except Siirt show strongly alternate bearing. Siirt has however a moderate alternate bearing.
6. Nut size: Nut size can change as a result of irrigation, fertilization and other cultivating practices.
 - Nut length (mm)(6.4.6): Nut length ranges from 18.33 to 20.30.
 - Nut width (mm)(6.4.7): Nut width ranges from 9.43 to 11.55.
 - Nut thickness (mm)(6.4.8): Nut thickness ranges from 7.20 to 11.02.
7. Nut shape (6.4.9): All Turkish varieties, except Siirt have elongated nut shapes – Siirt has an ovoid nut shape.
8. Nutshell colour: Ivory in Siirt, dark ivory in all others.
9. Hull characteristics
 - Hull dehiscence (6.4.1): Only Siirt has slightly dehiscent hulls. Other varieties are non-dehiscent.
 - Hull tip (6.4.3): This is strongly pronounced in all varieties except Uzun and Kırmızı.
 - Hull colour (6.4.4): Domestic varieties are generally red. Only Siirt has yellowish hull colour.
 - Hull colour homogeneity (6.4.5): Homogeneous in all domestic varieties (except Kırmızı).
10. Split nuts (%) (6.4.17): Splitting is a genetic trait typical of each variety (Ak 1998a) but it is affected by the type of rootstock employed (Crane 1975), agronomic practices such as irrigation (Goldhamer *et al.* 1987, Kaşka and Ak 1996) and fertilization. Irrigation is the most important factor influencing the splitting, split nut rate can be increased in fact with greater irrigation. Another strategy to increase the number of split nuts is to use more *Pistacia vera* male trees in the orchard (Ak 1992, Riazi and Rahemi, 1995). However, splitting rate generally may change from year to year (Ak 1998c). Siirt is the best variety with regard to

- splitting rate (Gökçe and Akçay 1993).
11. Suture opening (6.4.20): Cultural practices such as irrigation, fertilization, pest and disease management also affect the suture opening. The better the kernel development the greater the suture opening.
 12. Kernel flavour (6.4.30): Generally satisfactory in all varieties.
 13. Kernel colour (6.4.31): This is an important factor for fruit quality. The desirable nut colour is green or dark green. Green colour depends on both genotype and environmental conditions. There are three methods to increase its incidence; the first is to grow pistachio trees at high altitudes where temperatures are lower during summers; the second is to harvest fruits before they reach full maturity (Karaca *et al.* 1988, Kunter *et al.* 1995); the third is to use a proper pollen source for instance, the fruits pollinated by *P. terebinthus*, *P. atlantica*, *P. khinjuk* and other wild pistachio species (except *P. vera*) will not be split and their kernels are dark green or greenish in colour (Ak 1992). Generally non-split fruits have green or greenish kernels. Domestic varieties generally have a yellowish-green kernel colour.
 14. Oil content (%) (7.3.1.2): The average oil content of domestic varieties ranges from 56.27 to 62.30% (Karaca and Nizamoğlu, 1995).
 15. Protein content (%) (7.3.1.1): The average protein content of domestic varieties ranges from 20.00 to 26.38% (Karaca and Nizamoğlu, 1995).

Table 4. Some traits of domestic Pistachio varieties grown in Turkey

Traits	Uzun	Kirmizi	Halebi	Siirt	Beyazben	Sultani	Değirmi	Keten gömleği
1. Habit	Semi-erect	Semi-erect	Erect	Semi-erect	Semi-erect	Semi-erect	Semi-erect	Semi-erect
2. Inflorescence	Mid-early	Mid-early	Early	Intern.	Mid-early	Mid-early	Early	Mid-late
3. Fruiting rachis	Intermediate	Dense	Intermediate	Sparse	Sparse	Sparse	Dense	Dense
4. ripening period	Intermediate	Mid-early	Early	Mid-late	Mid-early	Mid-early	Early	Mid-late
5. Bearing	Significant	Significant	Significant	Moderate	Significant	Significant	Significant	Significant
6. Nut length	19.57	19.86	19.13	19.91	20.30	18.33	19.70	20.23
Nuts Nut width	10.58	11.53	10.43	11.55	9.90	9.43	10.47	9.47
ize Nut thickness (mm)	9.56	9.83	10.54	11.02	7.20	10.57	10.77	10.20
7. Nut shape	Elongated	Elongated	Elongated	Ovoid	Elongated	Elongated	Elongated	Elongated
8. Nut colour	Dark ivory	Dark ivory	Dark ivory	Ivory	Dark ivory	Dark ivory	Dark ivory	Dark ivory
9. Hull de- charac- teristic	Non- dehiscent	Non- dehiscent	Non- dehiscent	Slightly dehiscent	Non- dehiscent	Non- dehiscent	Non- dehiscent	Non- dehiscent
Hull tip	Pronounced	Pronounced	Strongly pronounced	Strongly pronounced	Strongly pronounced	Strongly pronounced	Strongly pronounced	Strongly pronounced
Hull colour	Red group	Red- purple group	Red group	Yellow- orange group	Red group	Red- purple group	Red- purple group	Red group
Hull colour homogeneity	No	Yes	No	No	No	No	No	No
10. Split nuts %	69	67	78	92	73	37	61	62
11. Suture opening	Narrow	Narrow	Moderate	Wide	Narrow	Narrow	Narrow	Narrow
12. Kernel flavour	Satisfactory	Satisfactory	Satisfactory	Satisfactory	Satisfactory	Satisfactory	Satisfactory	Satisfactory
13. Kernel colour	Yellowish green	Yellowish green	Yellowish green	Yellowish	Yellowish green	Yellowish green	Yellowish green	Yellowish green
14. Oil content%	56.64	58.89	56.27	56.70	58.13	62.30	59.11	59.35
15. Protein content %	22.26	24.77	23.47	20.88	23.45	20.00	23.31	26.38

Source: Gökçe and Akçay (1993).

Table 5. Some traits of foreign pistachio varieties grown in Turkey

Trait	Foreign varieties					
	Ohadi	Bilgen [†]	Vahidi	Sefidi	Mumtaz	
1. Habit	Spreading	Spreading	Spreading	Semi-erect	Spreading	
2. Inflorescence	Late	Late	Late	Mid-late	Mid-late	
3. Fruiting rachis	Sparse	Sparse	Sparse	Sparse	Sparse	
4. Ripening period	Late	Late	Very late	Late	Very late	
5. Bearing	Moderate	Moderate	Moderate	Moderate	Moderate	
6. Nut size (mm)	Nut length	17.00	18.47	20.52	20.24	21.04
	Nut width	12.03	13.72	15.12	12.36	13.65
	Nut Thickness	11.09	12.52	13.61	11.59	13.06
7. Nut shape	Round	Ovoid	Ovoid	Elongated	Ovoid	
8. Nut colour	Ivory	Ivory	Ivory	Dark ivory	Dark ivory	
	Hull	Non-dehiscent	Non-dehiscent	Non-dehiscent	Non-dehiscent	
9. Hull characteristic	Dehiscence					
	Hull tip	Little pronounced	Little pronounced	Little pronounced	Strongly pronounced	Strongly pronounced
	Hull colour	Orange-red group	Orange-red group	Yellow-orange group	Yellow-orange group	Orange-red group
	Hull colour homogeneity	No	Yes	Yes	No	No
10. Split nuts %	47	42	32	71	58	
11. Suture opening	Moderate	Narrow	Narrow	Narrow	Narrow	
12. Kernel flavour	Satisfactory	Satisfactory	Satisfactory	Satisfactory	Satisfactory	
13. Kernel colour	Yellowish	Yellowish	Yellowish	Yellowish	Yellowish	
14. Oil content %	58.97	51.75	55.67	56.77	55.40	
15. Protein content %	23.22	24.63	21.77	24.43	23.15	

Source: Gökçe and Akçay (1993). [†]This variety was introduced from Iraq by A.M. Bilgen.

Some traits of foreign varieties grown in Turkey

- Habit (6.1.2): Sefidi is semi-erect and all others varieties are spreading types.
- Flowering: International pistachio varieties are generally late flowering. Sefidi and Mumtaz are mid-late flowering; Ohadi, Bilgen and Vahidi varieties are late flowering.
- Fruiting rachis: In all foreign varieties grown in Turkey, fruiting rachis is sparse.
- Ripening period: Foreign varieties can be classified late to very late. Generally, late varieties mature at the beginning of October in Turkey. If the maturation period is late, drying of the fruits will be a major problem in cultivation.
- Bearing (6.43.10): Alternate bearing of fruits is moderate in all introduced varieties.
- Nut size: Nut size of introduced varieties is generally small.
 - Nut length (mm)(6.4.6): Ranges from 17.00 to 21.04.
 - Nut width (mm)(6.4.7): Ranges from 12.03 to 15.12.
 - Nut thickness (mm)(6.4.8): Ranges from 11.09 to 13.61.
- Nut shape (6.4.9): Bilgen, Vahidi and Mümtaz are ovoid while Ohadi is roundish and Sefidi elongated.
- Nutshell colour: ohadi, bilgen and vahidi – ivory; sefidi and mümtaz – dark ivory.
- Hull characteristics
 - Hull dehiscence (6.4.1): All non-dehiscent.
 - Hull tip (6.4.3): In ohadi, bilgen and vahidi it is little pronounced whereas in sefidi and mümtaz is strongly pronounced.
 - Hull colour (6.4.4): Generally orange all varieties.
 - Hull colour homogeneity (6.4.5): Homogenous in bilgen and vahidi, not homogenous in ohadi, sefidi and mümtaz.
- Split nuts (%) (6.9.17): Generally low. Sefidi having the highest splitting.
- Suture opening (6.4.20): All varieties have narrow suture openings except ohadi in which this trait is moderate.

12. Kernel flavor (6.4.30): Generally satisfactory.
13. Kernel colour (6.4.31): Yellowish for all varieties.
14. Oil content (%) (6.3.1.2): The average oil content of foreign varieties ranges from 51.75 to 58.97% (Karaca and Nizamoglu 1995, Ak and Kaşka, 1998).
15. Protein content (%) (6.3.1.1): The average protein content of domestic varieties ranges from 21.77 to 24.63% (Karaca and Nizamoglu 1995, Ak and Kaşka 1998).

Marketing

Pistachio nuts are generally marketed as salted and roasted as in-shell nuts. Roasting takes place in special ovens for 7 to 8 minutes at 110 °C or 4 to 5 minutes at 150-160 °C. During the roasting the nuts are continuously agitated. Roasted nuts are kept in plastic film lined sacks (Kaşka 1990).

In Turkey a certain amount of pistachio nuts is marketed as green kernels. The shells of nuts harvested a little earlier or grown at high elevations are split by hand crackers, separated from the kernels sieved and finally steam-sterilized before being sold in paper bags. The green kernels are more expensive and are used mostly in ice cream, pastry, halva (sweet dessert), baklava (sweet pastry), chocolate and other confectionery preparation (Kaşka, 1990).

Roasted in-shell pistachio nuts should be stored in a dry place to avoid absorption of moisture and the loss of flavour. Over the past ten years, Turkish salted and roasted pistachio nuts have been marketed in vacuum-sealed polyethylene bags of 250 g, 500 g and 1000 g (Kaşka 1990).

At the market, Turkish pistachio varieties are classified in two groups: (a) varieties with long fruits used for the table (Siirt, Ohadi, Mümtaz etc) and (b) varieties with green kernels for industrial use (Uzun, Kırmızı, Halebi etc.) (Ayfer 1964).

Conservation

The germplasm of Turkish and international varieties is being maintained in Gaziantep in the field collection of the Pistachio Research Institute. The same varieties are also preserved in Ceylanpinar Experimental State Farm. In order to safeguard the genetic identity of each variety, and to best contribute to their preservation, global and regional field collections should be established to this regard with the aim of preserving all varieties and possible ecotypes. Tekin and Akkök (1995) carried out studies on pistachio in Şanlıurfa, Gaziantep, Kahramanmaraş and Adıyaman Provinces. These studies have led to the selection of 16 types, all having different characters. These types have been subsequently planted in both Gaziantep (Pistachio Research Institute) and Ceylanpinar State Farm.

Concluding remarks

In Şanlıurfa, Gaziantep and other Turkish localities, pistachio trees will be irrigated and their yield will be further increased. Besides its positive effect on yield, irrigation also has a very beneficial effect on the increase of nut size and splitting incidence. Irrigation also reduces the percentage of blank nuts. Leaf size and number of current years shoots are also increased through irrigation (Goldhamer *et al.* 1987). As a result of this, the incidence of alternate bearing is expected to decrease in the future in Turkey.

Among the domestic varieties, Siirt is the most important for table use. It is therefore recommended that new orchards in the country be established using this variety.

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