

**REPUBLIC OF TÜRKİYE
HARRAN UNIVERSITY
INSTITUTE OF NATURAL AND APPLIED SCIENCES**

MSc THESIS

**DETERMINATION OF SOME TRAITS DIFFERENT PISTACHIO
CULTIVARS GROWN IN NORTH IRAQ**

Rajab Hassan Ali AL-MZORI

DEPARTMENT OF HORTICULTURE

**SANLIURFA
2021**

The study “**Determination of Some Traits Different Pistachio Cultivars Grown in North Iraq**” prepared by Rajab Hassan Ali AL-MZORI, under the supervision of Prof. Dr. Bekir Erol AK was unanimously accepted by the jury on 09/11/2021 as a MASTER'S THESIS at the Department of Horticulture of the Institute of Natural and Applied Sciences of Harran University.

Signature

Supervisor : Prof. Dr. Bekir Erol AK

Member : Assoc. Prof. Dr. Firat Ege KARAAT

Member : Ass.Prof. Dr. Yusuf NIKPEYMA

I confirm that this thesis is made in the Department of Horticulture and is organized according to the rules of our Institute.

Assoc. Prof. Dr. İsmail HİLALİ
Director of the Institute

Note: The use of the original and other references, tables, Figures and photographs used in this thesis without reference is subject to the provisions of the Law No. 5846 on Intellectual and Artistic Works.

CONTENTS

Page No

ÖZET	i
ABSTRACT.....	ii
ACKNOWLEDGEMENT	iii
LIST OF FIGURES	iv
LIST OF TABLES	v
LIST OF SYMBOLOS and ABBEVIATIONS	vi
1. INTRODUCTION	1
2. LITERATURE REVIEW	5
2.1 Pistacia L. Genus Botanical Classification	5
2.2 Origin of Pistachios	6
2.3 Pistachios Taxonomic State	7
2.4 Physical Properties of Pistachio Nut and Kernel	9
2.5 Morphological and Pomological Characteristics of Pistachio	11
2.5.1 Tree properties.....	11
2.5.2 The structure of root.....	12
2.5.3 Leaf properties.....	12
2.5.4 Flower bud structure and periodicity.....	13
2.5.5 Flower structure and pollination.....	14
2.5.6 Fertilization and fruit set	15
2.5.7 Branch structure	16
2.6. Pistachio Cultivars and Important Characteristics Thereof:.....	18
2.6.1 Long group	19
2.6.2 Oval group.....	19
2.6.3 Round group:.....	21
2.7 Ecological Requirements:	21
3. MATERIALS and METHODS.....	23
3.1. Materials	23
3.2. Methods	25
3.2.1. Morphological features.....	26
3.2.2. Some physical feature.....	30
3.2.2. Pomological analysis	31
3.2.3. Determination total faty acid contents	41
3.2.4. Determination of faty acid compositions.....	41
3.3. Statistical Analyzes	41
4. RESULTS and DISCUSSION	42
4.1. Some Morphological Features	42
4.1.1. Growth habit and branching situations	42
4.1.2. Leaf properties.....	42
4.2. Some Inflorescence Features	44
4.3. Some Physical Features	45
4.4. Some Pomological Features.....	47
4.5. Determination Total Faty Acid Contents	50
4.6. Determination of Faty acid Compositions	51
5. CONCLUSION and RECOMMENDATIONS.....	54
5.1. Conclusion	54
5.2. Recommendations.....	54
REFERENCES	55
PERSONAL INFORMATION	60

ÖZET

Yüksek Lisans Tezi

KUZHEY İRAK'TA YETİŞTİRİLEN DEĞİŞİK ANTEPFİSTİĞİ ÇEŞİTLERİNİN BAZI ÖZELLİKLERİNİN BELİRLENMESİ

Rajab Hassan Ali AL-MZORI

Harran Üniversitesi
Fen Bilimleri Enstitüsü
Bahçe Bitkileri Anabilim Dalı

Danışman: Prof. Dr. Bekir Erol AK
Yıl: 2021, Sayfa: 60

Bu çalışmada; Kuzey Irak bölgesinde yaygın olarak yetiştirilen bazı fıstık çeşitlerinin özellikleri descriptorlara göre belirlenmeye çalışılmıştır. Bahçelerden alınan meyve ve sürgün üzerinde bulunan yapraklar ile tomurcuklar Harran Üniversitesi, Bahçe Bitkileri Bölümü laboratuvarlarında analiz edilmişlerdir. Araştırmada; Abas Ali, Ahmad Aghaye, Malta, Siirt çeşitleri kullanılmıştır. Elde edilen bulgulara göre; meyve özellikleri bakımından hepsi birbirlerinden ayrı irilik, çıtlaklık ve ağırlıkta olmuşlardır. Meyve gözleri, yaprak boyutları da farklı olmuştur. Yaprak ile yaprakçık uzunluğu ve genişliği bakımından en uzun yapraklara Siirt çeşidinde, en kısa yapraklara ise Abas Ali çeşidinde olduğu belirlenmiştir. Fiziksel özellikler bakımından Abas Ali en çıtlak (82,4 %) meyvelere sahip olurken, en düşük (78,8 %) çıtlak meyve oranı Malta çeşidinde olduğu belirlenmiştir. 100 dane ağırlığı bakımından en yüksek (142,1 g) değer Malta çeşidinde olurken, en düşük (108,2 g) Siirt çeşidinde olduğu saptanmıştır. Meyve uzunluğu bakımından en yüksek (22,22 mm) değere Abas Ali çeşidinde, en kısa (20,20 mm) değere Siirt çeşidinde saptanmıştır. İç meyve özellikleri bakımından 100 iç meyve ağırlığına 79,2 g ile Ahmad Aghaye çeşidinde olduğu belirlenmiştir. Meyve iç randımanı bakımından en yüksek (58,79 %) değere Ahmad Aghaye çeşidinde olduğu saptanmıştır. Araştırmada kullanılan bu çeşitlerde yağ miktarı ve yağ asitleri kompozisyonları da belirlenmiştir.

ANAHTAR KELİMELEER: Antepfıstığı, tanımlama, çeşitler, Kuzey Irak.

ABSTRACT

MSc Thesis

DETERMINATION OF SOME TRAITS DIFFERENT PISTACHIO CULTIVARS GROWN IN NORTH IRAQ

Rajab Hassan Ali AL-MZORI

**Harran University
Graduate School of Natural and Applied Sciences
Department of Horticulture**

**Supervisor: Prof. Dr. Bekir Erol AK
Year: 2021, Page: 60**

In this study; The characteristics of some pistachio varieties widely grown in the Northern Iraq region were tried to be determined according to descriptor. The leaves and buds on the fruit and shoot taken from the gardens were analyzed in the laboratories of Harran University, Department of Horticulture. In the research; Abas Ali, Ahmad Aghaye, Malta, Siirt varieties were used According to the findings obtained; In terms of fruit characteristics, they were all different from each other in size, crackness and weight. Fruit eyes and leaf sizes were also different. In terms of leaf and leaflet length and width, it was determined that Siirt variety had the longest leaves and Abas Ali variety had the shortest leaves. In terms of physical properties, Abas Ali had the most cracked fruit (82.4 %), while the lowest (78.8 %) cracked fruit rate was determined to be in Malta. In terms of 100 grain weight, the highest (142.1 g) value was found in Malta variety, while the lowest (108.2 g) was found in Siirt variety. In terms of fruit length, the highest value (22.22 mm) was determined in Abas Ali cultivar, and the shortest (20.20 mm) value was determined in Siirt cultivar. In terms of internal fruit characteristics, it was determined that it was in Ahmad Aghaye variety with 79.2 g per 100 kernel weight. It was determined that the highest value (58.79%) in terms of fruit kernel yield was in Ahmad Aghaye variety. Faty asit content and faty acid compositions were determined in the cultivars which used experiment.

KEY WORDS: Pistachio, descriptor, cultivars, North Iraq.

ACKNOWLEDGEMENT

In the name of Allah, the Most Gracious and the Most Merciful

First, I must thank Allah for His Mercy and Support, for always being there to hear my prayers, for helping me succeed in all the stages of my studies especially for giving me time and health to finish this research work. I would like to give an endless thanks and appreciation to my thesis supervisor, Prof. Dr. Bekir Erol AK, for his support, precious ideas, feedback, and advice in all stages, from beginning to the end of my project. My special thanks to PHD Students Birgul DIKMETAS and Ibrahim Halil HATIPOGLU helped me each step of analysis.

Indeed, my family who have supported me and encouraged me during the tough and hard times within the period of doing my master and preparing my thesis without their help I would not have reached this stage. Finally, thanks to all the professors and friends and my family who have encouraged me to finish this research.



LIST OF FIGURES

Page No

Figure 2.1. The distribution of pistachio in Asia and Europe. Textured area is the wild pistachio savannah of Badgtis region (Maggs 1973).....	7
Figure 3.1. Abas Ali tree and fruits	24
Figure 3.2. Ahmad Aghaye tree and fruits	24
Figure 3.3. Malta tree and fruits	25
Figure 3.4. Siirt tree and fruits	25
Figure 3.5. Tree crown shapes	26
Figure 3.6. Leaf length	27
Figure 3.7. Leaf width	27
Figure 3.8. Terminal leaf length and width	28
Figure 3.9. Terminal leaflet shape	28
Figure 3.10. Terminal leaflet apex	29
Figure 3.11. Terminal leaflet base	29
Figure 3.12. Female flower bud shape	30
Figure 3.13. Homogeneity of fruit skin (exocarp) color.....	31
Figure 3.14. Fruit shape scale.....	32
Figure 3.15. Front and lateral view of shell.....	33
Figure 3.16. The shape of the shell depression in the fruit stem part	33
Figure 3.17. The height of the shell in the fruit stem	34
Figure 3.18. Nut suture height.....	34
Figure 3.19. Snap positions of fruit peels.....	35
Figure 3.20. Suture opening	36
Figure 3.21. Fruit length.....	37
Figure 3.22. Fruit width	37
Figure 3.23. Fruit thickness.....	38
Figure 3.24. Average fruit weight	38
Figure 3.25. Kernel fruit length.....	39
Figure 3.26. Kernel width	39
Figure 3.27. Kernel thickness.....	40
Figure 3.28. The part of fruits which are weighted	40
Figure 4.1. Terminal leaflet (A: Abas Ali, B: Ahmad Aghaye, C: Siirt, D: Malta)	44
Figure 4.2. Flower buds of cultivars.....	45

LIST OF TABLES

	Page No
Table 1.1. The production of pistachio worldwide (Atli et al., 2003).	3
Table 3.1. Climatic data in Duhok (2014-2020 years)	23
Table 4.1. Growth habit and branching	42
Table 4.2. Some leaf properties of different pistachio cultivars grown in Northern Iraq	42
Table 4.3. Some leaflet properties of different pistachio cultivars grown in North Iraq	43
Table 4.4. Subjective leaflet properties of different pistachio cultivars	43
Table 4.5. Some Female flower bud shape and colour of different pistachio cultivars grown in North Iraq	44
Table 4.6. Phenological observations on flowering time of different pistachio cultivars grown in North Iraq in 2020.	45
Table 4.7. Some physical traits of different pistachio cultivars grown in North Iraq.....	46
Table 4.8. Suture opening, endocarp thickness and Some other traits of different pistachio cultivars grown in North Iraq.....	46
Table 4.9. Some pomological traits of different pistachio cultivars with endocarps grown in North Iraq	49
Table 4.10. Some pomological traits of kernels different pistachio cultivars grown in North Iraq	49
Table 4.11. Some weight and shelling percentages of different pistachio cultivars grown in North Iraq	50
Table 4.12. Total fat contents of different Pistachio cultivars grown North Iraq	51
Table 4.13. Faty acid composition of different pistachio cultivars grown North Iraq.....	52

LIST OF SYMBOLOS and ABBEVIATIONS

%	Percentage
µm	Mikrometer
cm	Centimeter
FAME	Fatty Acid Methyl Ester
FID	Flame Ionization Detector
Fig	Figure
g	Gram
GC-MS	Gas Chromatografy- Mass Spectrometer
IPGRI	International Plant Genetic Resources Institute
kg	Kilogram
m	Meter
ml	Milliliter
mm	Millimeter
UPOV	The International Union for the Protection of New Varieties of Plants



1. INTRODUCTION

Pistacia vera is grown suited in microclimate areas and 30-40 altitude in the world. Iran have the biggest (420 000 ha) production areas in the world. Turkey is second country. Yet its yield is very low when compared the production areas (Arpaci et al., 2005). This condition makes the researcher to think about the problems and solutions. Pistachio is growing rocky and high lime content of soil, unfertile and rainfed conditions. It has grown non-irrigated areas so far. Recently, thanks to the Atatürk Dam, irrigation can be done in pistachio orchards in the Southeastern Anatolia region (Kaska, 1995).

Every country where pistachios are produce has its own varieties. According to Sheibani (1995) there are 60 different cultivars in Iran. But the most produced cultivars are Kaleh Ghochi and Ohady. In Turkey, Siirt. Uzun and Kirmizi are the most produced cultivars. There are domestic regional varieties such as Keten Gomlegi. Turkish cultivars are preferred because of their homogeneous green kernels and good taste in the USA and many European countries. In U.S.A. the most produced cultivar is Kerman. In Syria have different cultivars that common such as Ashoury, Oleimy, White Batoury etc. But major cultivar is Ashoury (Ak, 2014).

The tree of pistachio is one of a dioecious plant in which it has a female and male flowers which grow on separated tree plants (Acar and Ak, 2001). The flowers of pistachio do not contain petal, consequently, honey bee do not attraction to assist pollination. Therefore, pollination is usually performed by the wind. In order to achieve a required and better economic production, fertilization and pollination are essential. In growing areas of pistachio trees, providing large amounts of pollens is so critical, but most of the pistachio producers are not aware of this considerable point on the pistachio performance (Ak et al., 1995). Morphological characterization of plants, viability of pollen grains and pollen tube growth are considered as important characteristics of plants (Ak, 1992).

Yet, more than few methods are applied so as to discriminate the differences between the different varieties of pistachios. Identification methods are typically founded depending on the shape of pollen and external pistachio features (Moore and Webb, 1978). Fogle (1977) recommended that the pollen grain morphology include pollen pores, shape, exine pattern and size, are related criteria for cultivars identification (Moore and Webb, 1978). There are considerable differences between different species of a particular pistachio genus, in shape, size and surface pollen features (Marthens and Fretz, 1980; Davarynejad et al, 1995). Other scientists have stated which the pollen shape and pollen size are unstable with dissimilar within cultivars and species (Talaie and Imani, 1998). This study was designed to distinguish between four types of pistachio cultivated in Kurdistan Region of Iraq in which two are of Iranian origin, one of Turkish origin and the last one the origin is unknown which was called by the author as Malta type. Pistachio contains many important dietary components.

Pistachios consist of low-saturated fatty acids and this could be a worthy source for mono-unsaturated fats. A daily consumption of pistachio around 55 – 60 grams can cause a reduction in the blood pressure in the older people. The powder of pistachio is used in confectionery and the green outer shell it is used for animals feeding such as ruminants like cows and sheep and for poultry. In addition, pistacia oil is used in the production of medicines, cosmetics and different dishes.

Pistachio is a plant that has long been raised and cultivated in different areas of Turkmenistan, Turkey, Iran, Iraq, the United States of America and Afghanistan (Razavi, 2006). In these areas, forests consisting of natural wild pistachio trees are seen. It is supposed that pistachio trees have been cultivated well-nigh 4,0000 years. The major production area of pistachio in the Middle East is especially Iran. Iran's Rafsanjan region is one of the largest pistachio production areas worldwide due to its favorable climatic conditions. It might be believed that Iranian and Turkish pistachios quality is unique in the whole world. To date, in some promising regions like Greece, California, Italy, Turkey, Iraq and Syria, pistachio is produced as well as a result of its economic importance (Razavi, 2006).

In Turkey, the production of pistachio has been undertaken under non-irrigated conditions with production about 50,000 tons in a single year. With this amount of production, Turkey ranks third in pistachio production. Iran and the USA are in first and second place, respectively (Table 1.1.). In Turkey, the production is carried out with unirrigated system whereas in USA and the Iran, pistachio is produced under irrigation systems. FAO records were given Table 1.1. The order was Iran first, second USA and Turkey is third country in production.

Table 1.1. The production of pistachio worldwide (FAO, 2019)

Country	Annual production (tonnes)				Average
	2015	2016	2017	2018	
Iran	430.000	574.987	648.934	551.307	551.307
USA	122.470	406.646	272.292	447.700	312.277
Turkey	144.000	170.000	78.000	240.000	158.000
China	74.226	74.968	75.290	74.828	74.828
Syria	28.800	28.800	28.800	28.800	28.800
Greece	9.745	11.265	11.836	8.558	10.351
World	830.592	1.292.643	1.141.118	1.377.790	1.160.536

During the last six decades, Pistachio, due to its consumption worldwide, has been considered as one of the highest products commercially. The major pistachio produced habitat is the Middle East, especially Iran and Iraq. Iran's Rafsanjan region is one of the main areas of pistachio production in the world. In 2004, Iran had 53% of the pistachio growing areas in the world. Pistachio cultivation in Kerman province was slightly more than 45% in 2003. 20% of the total pistachio orchards in the world are in the Rafsanjan region. (Razavi, 2006).

In 2004, the pistachio growing area of the USA was about 6-7% of the world's pistachio area. In 2004, the share of the USA and Iran in the production of pistachios, was 13% and 44%, respectively. In 2003 the total pistachio production worldwide was more than 660,000 tons, 16 – 17% was belonging to Rafsanjan. The total investment In the USA, for maintenance and establishment of only ten decare of pistachios'

orchards to obtain the economic production is nearby 1.5 more than expenses in Iran. Yearly operating costs of bearing pistachio orchards for one hectare in the USA is well-nigh 4 times more than operating costs in Iran (Razavi, 2006).

Iran, USA, Turkey, Syria, Greece and Italy are at the top of pistachio exports in the world, respectively. In 2003, Iran was the largest exporter in world pistachio exports with 69%, while the USA took the second with 8.9%. (Razavi, 2006). Whereas, Turkey was the third by producing about 1% of pistachio production (Atli et al., 2003). In 2003, the five countries with the highest peanut imports in the world were Hong Kong, Spain, Italy, Germany and China. 55-91% of the total imported pistachios are supplied from Iran and 1-32% from the USA. At 2006, markets such as in Hong Kong, China, Australia, Mexico, India, Russia and Syria, are more important than the markets in Europe. At 2006, about 39% of pistachios were sent to CIS countries like Kyrgyzstan and Kazakhstan. In 2003, the total imports of Spain, India, Australia, Russia, Mexico, Kyrgyzstan and Kazakhstan, were 91.5, 94.3, 79.2, 97.1, 89, 94, 85% of Iran and 2.3, 1, 10.4, 7.5, 0.5, 0, 0 percent of the USA, respectively. Syria's pistachio market was seized by Iran in 2002, and the United Arab Emirates' total pistachio imports that year were 96% from Iran and 1% from the USA. (Razavi, 2006).

Due to the fact that pistachios are economically important, its flavor, production quantity and quality and the characteristics of its tree is also of a great significance; therefore, the main purpose of the present study was the differentiation between four types of pistachios cultivated in Kurdistan Region of Iraq in which two types were of Iranian origin, one of Turkish and the other was Kurdish origin named Malta species.

The objective of this research is to determine fruit and botanical traits of different pistachio cultivar or type which grown at Northern Iraq in Duhok province.

2. LITERATURE REVIEW

2.1 Pistacia L. Genus Botanical Classification

The *Pistacia* L. genus is an insider of the family Anacardiaceae that as well comprises other members like mango, cashew, poison ivy, pepper tree, sumac and poison oak. The genus *Pistacia* L. is known to consist of 11 or more species (Zohary, 1952; Whitehouse, 1957; Kokwaro and Gillett, 1980; Kafkas and Perl-Treves, 2001; Parfitt and Badenes, 1997). The only commercially important species *Pistacia vera* L. has edible (edible) nuts. Other species of the *Pistacia* L. genus have been used as rootstock for *P. vera* for many years. *P. vera* is considered to be the oldest species, and all other species are probably considered derivatives of it (Zohary, 1952). Wannan and Quinn (1991) compared flower morphology among sister groups of the genus *P. vera*. All of its species are dioecious, diploid dicots in which male and female are separate trees. Ila et al. (2003) stated a diploid chromosome number of thirty for *P. atlantica* Desf., *P. eurycarpa* Yalt., *P. vera* and *P. terebinthus* L. These results were reliable with an analysis from Parfitt and Lin in unpublished research, of eleven species in which $2n =$ twenty-eight or thirty. Previous studies (Ghaffari and Harandi, 2001) of $2n =$ twenty-four for *Pistacia khinjuk* stocks seem to be not correct. The classification of molecular taxonomy of the genus have been informed by Parfitt and Badenes (1997), and Yi et al. (2008), the main differences from the 1952 Zohary classification include the definition of *P. chinensis* as a separate sister species to *P. integerrima* and the species classification into two sections.

Pistacia species consist of dioecious individual (Ozbek and Ayfer, 1958; Crane, 1974; Kafkas et al., 2000; İsfendiyaroğlu and Zeker, 2009), and pollinated by wind. Female and male apetalous flowers are borne in panicles on the two different trees. More than a hundred flowers can be found on each panicle; typically, one hundred to three hundred flowers have per bloom (Fig. 21.2.). *P. vera* produces a nut, which is marketed qua a dried product in-shell after the husk removal. The nuts of pistachio are drupes, which is classified similarly to the stone fruits and almonds. All drupes are consisted of 3 parts: first, exocarp; second, a fleshy mesocarp, and third, an endocarp

which encloses a seed (Prafitt et al., 2012). The pistachio shell or endocarp encloses a single oil rich seed and typically splits with its lateral suture, when the pistachio nut is ripe. The exocarp changes the color from green to white or even at maturity it becomes a white-purple colour. The kernels of pistachio have two cotyledons and a papery seed coat. The growth habit of a tree is considered a strong apical dominance and does not have vegetative buds in older trees (Prafitt et al., 2012). In addition, the root system of pistachios is an extensive system. Under normal conditions, a central tap root of *P. vera* does not develop, but a highly-branched root system is produced with several fine-roots that allow the pistachio tree to proficiently extract nutrients and water. The leaf of the tree is pinnately compound. Each of its leaf can sub-tend a singular axillary bud. Most of its lateral buds are differentiated into inflorescences and then produce male or female flower that bearing rachi (Prafitt et al., 2012).

Pistachios are categorized by an elongated juvenile period, normally bearing few pistachio nuts before 5 years of planting. The full bearing is achieved between 10 – 12 years of their age. The growth habit of its tree is upright, which is characterized by an apical dominance strength and an absence of lateral vegetative buds in trees that are older. These features have strong implications for younger tree training, mature tree pruning, and rejuvenation of fruiting wood in the older trees (Ferguson et al., 2005).

2.2 Origin of Pistachios

The pistachio trees are native to Asia Minor and western Asia, where it is to date found growing in several dry and hot locations in Palestine, Lebanon, Syria, Iraq, Iran, Southern Europe, India and the Asian and African countries containing desert. It was introduced first to Europe at the time of the Christian era. The earliest pistachio that introduced to the United States of America were by the USDA plant exploration services in the 19th century in the 1890s. The first introductions of California were planted at the Chico Plant Introduction Station, in California in the Northern Sacramento Valley in the beginning of 20th century and mainly at 1904 (Ferguson et al., 2005).

The pistachio that is cultivated for commercial purposes is the species *P. vera* L. this species is native to the Central Asia and the Middle East. There are 2 centers of diversity of cultivated pistachio: one contains the Europe Mediterranean regions, the Middle East and Northern Africa. The second one includes the Eastern part of Zagros Mountains between Caspian Sea and the Crimea (Maggs, 1973; Hormaza et al., 1998). The Vavilov center of diversity for the wild *P. vera* location is in Southern Turkmenistan, Northern Iran and some parts of Afghanistan as well. The region referred to as Badgtis is a region on the border of Turkmenistan and Iran. It is an area of rolling hills that is covered by dispersed stands of *P. vera* trees and grasslands. This area with the highest natural diversity; other regions of Iran with mainly native pistachio stands were grafted with clones of improved cultivars. (Maggs, 1972, 1973) (Fig. 2.1.).

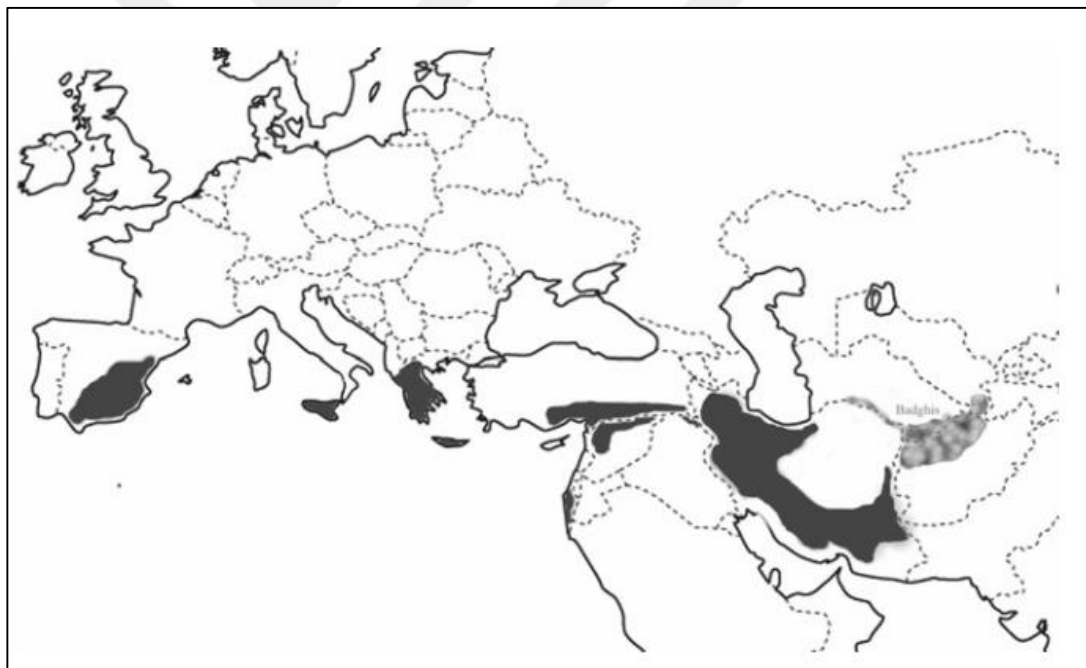


Figure 2.1. The distribution of pistachio in Asia and Europe. Textured area is the wild pistachio savannah of Badgtis region (Maggs 1973)

2.3 Pistachios Taxonomic State

Order: Sapindales

Family: Anacardiaceae

Genus: *Pistacia*

Species: *Pistacia vera* L. (pistachio) 2n: 20

There are eleven kind of the genus *Pistacia* involved in the family of Anacardiaceae, in which they are valuable as not only the fruit trees but also the ornamental plants (Özbek, 1978). The grouping between species is established on the development status of the flower, leaf, fruit and tree. The *Pistacia* genus plants were classified as follows in these groups (Zohari, 1952).

- A. Lenticella
 - Pistacia mexicana*
 - Pistacia texana*
- B. Lentiscus
 - Pistacia lentiscus*
- C. Butmela
 - Pistacia atlantica*
 - Pistacia mutica*
- D. Terebinthus
 - Pistacia khinjuk* Stocks
 - Pistacia terebinthus* L.
 - Pistacia vera* L.
 - Pistacia chinensis* Bge
 - Pistacia palaestina* Boiss

Both cultivated and wild type of pistachio species can be found in Turkey in below regions (Arpacı et al., 1997):

-Southeastern Anatolia Region:

P. vera, *P. khinjuk* and *P. terebinthus* species are dominant types in Southeastern Anatolia region. Additionally, due to interspecific crossing, there are new hybrids found. The highest number of trees are found in this region, more than 90% of cultivated pistachio production as well.

-Mediterranean and Aegean Regions:

P. atlantica, *P. terebinthus*, *P. mutica*, *P. palaestina*, *P. lentiscus*, and *P. vera* are found in Mediterranean and Aegean regions. All species excluding *P. lentiscus* may be used as a rootstock of pistachio (Tekin et al., 2001).

-Passage Region include North Mediterranean- Inner Aegean and Central Anatolia Regions:

P. vera, *P. mutica*, *P. atlantica* and *P. terebinthus* are found in these regions, which, however, have the smallest number of pistachio species. In the research regarding an appropriate selection of rootstocks for pistachio, and determining species that needs preservation as well as grafting, it was detected that the types that may be used as a rootstock for pistachios were spread all over Anatolia, with the exception for Eastern Anatolia uplands and the coastline of the Black Sea Region (Tekin et al., 2001).

2.4 Physical Properties of Pistachio Nut and Kernel

The kernels of pistachio are good fat source (50 – 60%) and also contain unsaturated fatty-acids (linolenic, oleic linoleic and acids), that are essential for the human nutrition (Maskan & Karatas, 1998; Shokraii, 1977). It is consumed in snack foods and candies. The shell (endocarp) of pistachio nuts split their sutures, which is a necessary trait of it due to the fact that pistachio nuts are frequently marketed in-shell for snack foods. For the reason of the deep-green pistachio kernels color, it is favored in the pastry industries and ice cream (Woodroof, 1979). When pistachios are arrived at the plant processing factory, the following procedures are directed: (1) de-hulling, for separating the soft hull from pistachio nuts; (2) blank and trash separation, for removing blank pistachios, and then, trashes like remaining shells, small branches, and leaves of its tree; (3) unpeeled pistachios separation, for removing unripen and unpeeled nuts; (4) washing, in which it involves water spraying at high pressures on the pistachios so as to clean the nuts; (5) drying process, so as to decrease the moisture

content of pistachios from 37 – 40% to the suitable level; (6) split nuts separation, for separating split nuts from ones that are non-split; (7) roasting nuts; (8) salting; and finally (9) the packaging (Nakhaeinejad, 1998).

The physical properties of pistachio nuts and its kernels are significant to propose the equipment for transportation, separation, processing, storing, and sorting. Such equipment designing without considering the aforementioned points might yield poor results. Thus, the consideration and determination of these characteristics has a vital role. The main physical properties of nuts of biological materials that are dependent on moisture are size, shape, mass, porosity, true density, bulk density, and static friction factor against a number of surfaces (Mohsenin, 1980). Researchers have considered these properties for several seeds and grains; for instance, cashew nuts (Balasubramanian, 2001; Oloso & Clarke, 1993), soybean (Dehspande et al., 1993), pumpkin seeds (Joshi et al., 1993), lentil seeds (Carman, 1996), the seeds of sunflower (Gupta & Das, 1997), coffee (Chandrasekar & Viswanathan, 1999), white lupin (Ogut, 1998), shea kernel (Olajide et al., 2000), terebinth fruits (Aydin & Ozcan, 2002) apricot pit and its kernel (Gezer et al., 2002), and the pigeon pea (Baryeh & Mangope, 2002). Nonetheless, the pistachio kernel physical properties have not yet been determined, and there is inadequate information on properties of some pistachio nuts such as Kerman pistachio nuts (Hsu et al., 1991), which is insufficient to design equipment and storage systems for pistachio nuts in Iraq, Turkey and Iran. Physical dimensions, shape and size, of pistachio nuts and kernels are considerable in sizing, sorting, sieving and other processes of separation (Kashaninejad et al., 2006).

Pistachio nut and kernel densities are of a great necessity to design the equipment for storing and processing like dryers, hullers and bins. The absorbency affects the airflow resistance through bulk nuts of pistachio. Terminal velocity is highly critical in the designing of pneumatic conveyor, the transportation of pistachio nuts and kernels with using air, and separating the pistachio nut and kernels from unwanted materials for example leaves, shells, small branches, hulls, and blank pistachios. In addition, the terminal velocity of pistachio is affected by the density, size, shape, and moisture content of nut and kernel samples. During the processes of harvesting, them

handling, processing and finally the storage process of pistachio nut, the pistachio product carries frictional forces on the components of machinery or structures of the storage. The magnitude of these frictional forces can affect the amount of the required power to convey the material (Kashaninejad et al., 2006).

2.5 Morphological and Pomological Characteristics of Pistachio

2.5.1 Tree properties

A pistachio tree is deciduous, single-trunk, perennial and dioic plant, which means the reproductive systems of female and male are placed on separate trees.

The tree crown of pistachio is shaped resembling an open umbrella that can grow both laterally and upwards. Pistachio tree (*P. vera*) grows up-to 3 to 10 meters (Ayfer, 1964). The development of crown can depend on the structure of soil, ecology, rootstock as well as the cultivar characteristics. The three forms a high and wide crown under appropriate environmental conditions and in deep soil. *P. atlantica* could form a high crown and grows up-to 20 m, which is twice as *P. vera* (Bilgen, 1973). The grafted cultivar can also form a high crown. *P. terebinthus* displays small crown formation. *P. khinjuk* and *P. vera* rootstocks, in contrast, develop crowns that are medium in the size. *P. terebinthus* can comprise multiple trunks while other types have a single trunk (Tekin et al., 2001).

Generally, species of *Pistacia* are resinous. There are high amounts of resin produced from *P. lentiscus*. Therefore, it is not used as a rootstock. It is, instead, used a gum producing tree. It remains green throughout the year which is named evergreen. All species of pistachio do not want to have thick branches be pruned. The pistachio tree can become completely dry with extreme loss of its resin; that is the plant sap (Tekin, 2014; Tekin et al., 2001).

2.5.2 The structure of root

All pistachio trees having a strong structure of root. They not only have a tap root in which it can drive extremely deep, but also having fibrous roots that can mostly grow laterally (Özbek and Ayfer, 1957). A thirty-five years old tree of pistachio was found to have roots of 16 meters depth that is when the tree roots were recognized in a water-well in the same orchard (Tekin, 2014). It was also discovered that the seedling rootstock tap root was 35 cm in high above-ground can go almost 2 meters on the orchard of the Research Institute of Pistachio. The stem development comes after the development of the root of pistachio tree. The fibrous roots that are dense may be seen at a 20 to 40 cm depth but the moderate fibrous root may possibly be observed at a 40 to 60 cm depth nearby the tap root (Tekin et al., 1995).

Due to the fact that the pistachio tree having a strong root structure, therefore, it can increase its resistance to not only aridity but also other harsh environments. This properties of the root structure strength is considered as the net security of the pistachio tree because it can ensure the use of ground-water with extremely arid and hot environmental conditions (Tekin et al., 2001).

2.5.3 Leaf properties

Pistachio plants have compound leaves. The tree almost always has a terminal leaflet. It may be larger than or might be the same size as of the other leaflets (Bilgen, 1968). It has 3 to 7 leaflets. The rachis, the main axis or stem, is not winged. The leaves have a color of dark green with an upper surface brightness and an opaque, or not transparent, undersurface (Tekin et al., 2001).

The leaflets of the female pistachio plants are in oval shape. On the other hand, the male pistachio plants' leaves are sharp and narrower. It was discovered that female trees have less dense leaves overall (Tekin et al., 2001).

2.5.4 Flower bud structure and periodicity

Each leaf base has only one flower bud in general and are divided into 2 which are leaf buds and fruit buds. Growth buds are noticeably smaller than fruit buds. In all species of the genus *Pistacia*, the fruit buds of female plants are smaller than flower buds that male trees have. Both flower buds and fruit buds of pistachios are formed 1 year before. As stated by Crane and Nelson (1971), the actual size of flower buds is reached in June and begin falling off in the second half of the same month. Crane and Iwakiri (1988) indicated that the drop of fruit bud in pistachios is faster with the development of embryo and finishes when fruits become mature. In female plants, under insufficient maintenance, with the 2nd period of the growth (starting of embryonic growth), fruit buds starting falling off and is continued until the fruits eventually become mature (Tekin et al. 1995).

The drop of the fruit bud can vary relying on the crop load of the tree, cultivar characteristics and the structure of soil. Generally, the amount of drop of fruit bud is lower of the oval group cultivars (Tekin and Akkök, 1995). The degree of fruit bud drop is reduced in orchards that are irrigable, cared well and rich in plant nutrients and that have the soil structure which is loamy-clay that drains deep, while it goes almost 98 percentage in barren lands and nonwell-cared for orchards (Tekin et al., 2001). Consequently, the trees do not have any production as well as produce extremely low product amount in the subsequent year. This phenomenon is called periodicity (alternate bearing) and is one of the foremost issues in pistachio plants. Timely application of an adequate fertilizer amounts on the soil and leaves can reduce the drop of fruit bud by 38 percentage and can considerably contribute to prevent periodicity by increasing the production by 50 percentage as well as can enhance the quality of the product (Tekin and Güzel, 1992).

There is also the presence of periodicity in citrus and olive trees. Although, these trees do not have fruit buds that are in an “on” year as the pistachio trees do have. In contrast, pistachio shows the formation of fruit bud and these buds can be fallen off according to the crop load of the pistachio tree, soil structure, cultivar, and protection

conditions. In Turkey, for instance, pistachios are generally grown on both arid and sterile lands. Thus, it can be said that the most considerable cause of the drop of fruit bud, and henceforth the low production of pistachios in Turkey is inadequate conditions of cultivation, mainly irrigation and fertilization, in addition to the cultivar characteristics (Tekin et al., 2001).

2.5.5 Flower structure and pollination

Both female and male flowers are found on separated pistachios' trees (also called dioic). Flowers can be in panicles. Male pistachio trees do not carry fruits but they produce pollens. No inconsistency is found between the species of *Pistacia* in terms of both female and male sexes. As a general rule, the trees of male blossom earlier and then can provide pollens (protandry). In pistachios, pollination can be achieved by wind. Pollination process is generally lasting 3 to 7 days in the male trees (Açar, 1997). New pistachio cultivars, which produce pollens for 8 to 10 days had been developing in several research. From the bottom of the panicle, blooming starts and passages up-wards. Their flowers do not contain petals. Female panicles are generally longer than male panicles. Male panicles having a color ranged from cream to the light red and they can have 200 - 600 flowers (Atlı et al., 1995). While female panicles have lower number of flowers, which are about 120 - 140 flowers. When only 20 to 25 of its flowers produce fruit that are not hollow, this is meaning satisfactory crop yield, but if 40 of these flowers produce fruit, this is considered a high crop yield (Açar, 2012). The period of blooming can last 10 to 12 days for female flowers (Kuru and Ayfer, 1984). In male pistachio trees, blooming can start when anthers producing pollen in 10 to 15 panicles. In contrast, in female trees, the day when 5 percentage of the flowers in a panicle blossom and also the stigma portion of the pistil when is reaching accessible maturity, and turning its color into creamy and green color is believed as the start of the blooming stage. While the period that 75 percentage of the female flowers changes into creamy green color is considered the full blooming period. When all the anthers of the male flowers rupture or burst and 90 percentage of the female flower pistils changes into green, this can indicate the end of bloom (Ayfer, 1967; Kuru and Ayfer 1984; Tekin et al., 2001).

Pistachios are dioic plants with unique structure of flower. Male flowers can pollinate via wind and then spread their pollen. Thus, in cultivation, it could be more appropriate to consider the planting in a mind to have a greater number of male pistachio trees in the normal direction of wind (Tekin et al., 2001).

2.5.6 Fertilization and fruit set

In pistachio trees, the development of flower must be completed, in addition to fertilization and pollination should happen for the formation of seed. Each pistachio fruit has an ovule. Fertilization is necessary mainly because the seeds are used as fruit. However, the pericarp can develop in non-fertilized fruit, there will be parthenocarpy because there is no formation of the seed. This is not preferred for pistachios. Four hours after the arrival of the pollens to the stigma, most of the pistachio pollens are germinated (Ayfer, 1967). Pollen tubes will enter the chalaza after growing over the style, and also the space between the chalaza and style (Okay, 2014). Pollen tubes firstly grow down inside the chalaza, then extend to the ovule, and enter to the vascular tissue, hence, reaching the embryonic sacs after the achievement of curvature together. Pollen tubes then penetrate the sac of embryo from the end of micropylar via the nucellus and chalaza; thus, this process is known as chalazogamy (Ayfer, 1967). The pollen tube that can first reach the sac of embryo will release its contents to the embryonic sac through the synergids, as a result, fertilization happens (Okay, 2014).

Both processes of pollination and fertilization happen within 20 to 28 hours (Ayfer, 1967). Some scholars described this time to be 21 hours (Whitehouse et al., 1964). After fertilization, the formed zygote undergoes a dormant (temporarily inactive or sleeping) period for 45 to 50 days. The pericarp starts developing fast during this period of the zygote, the sleeping period. Both the ovule and endosperm are, in addition, quickly developed in this period. The development of pericarp lasts 50 to 55 days, then, endocarp can reach a required size and hardness. In pistachio, this stage when the pericarp quickly develops and when the zygote is in a sleeping period is known as the "1st Growth Period". While, the period of approximately 10 days later, in which the embryo rapidly develops and the seed matures for 45 - 55 days is

known as the “2nd Growth Period” (Ayfer, 1967). Afterwards, un-fertilized flowers fall off from the trees of pistachio. While the whole panicle might fall off, fruits will be gained from flowers that are fertilized, and the hollow fruit from not fertilized flowers, which have made a pericarp. These fruits do not have any economic value. The development of embryo is completed when the 1st and 2nd periods of pistachio growth are accomplished. Maggs (1975) described that the fruit is matured fully 4 to 6 weeks after the embryo development completion; whereas, Kuru et al. (1988) stated that fruits entirely filled the shell approximately 4 months after the pollination.

There must be appropriate and acceptable number of male pistachio trees in the orchard so as to accomplish the formation of seeds in the pistachio. Due to the fact that fertilization occurs by wind, thus, rainy weather with high relative humidity is a significant reason of the formation of hollow fruit. Splitting the nuts of pistachio while on the tree is a significant quality indicator. Trees that split nuts can have higher yields. They are also easier to process. For that reason, they could have higher market prices. Harvesting pistachios 3 to 5 weeks after whole embryonic development guarantees that the fruit is entirely mature and developed, and that the hard-shell is also split. It is likely to be said that pistachio fruits are fully matured and are prepared for harvesting roughly 4 months after the occurrence of the first bloom (Tekin et al., 2001).

2.5.7 Branch structure

There are four types of branches that pistachio trees have as follow (Tekin et al., 1995).

2.5.7.1 Water sprouts

They are originated straight from the central stem. They completely comprise shoot buds. They, therefore, are not used as scions. They can grow about 40 to 60 cm and are used mainly for rejuvenation pruning in old pistachio trees. These are shoots that are emerged after pruning the thick pistachio branches. With the purpose of applying the optimum working graft to a wild tree type, it is essential to prune the tree

ahead in time. This system contains a special practice and a branch that is thick is pruned by separating small branches. Numerous water-sprouts develop under the area that is pruned by the promption of adventitious buds. There are 2 to 4 water-sprouts that are developed well are left in each sector, relying on the branch diameter, and all other water-sprouts are removed in March and April. Those that can reach the thickness of budding are budded in June in the same year while the others in the next year (Tekin et al., 2001).

2.5.7.2 Monopodial branch

This type of branch is shaped when the terminal bud, which is grown at the tip of shoot, from the earlier year shoots forth. This branch contains shoot buds and all these buds may be used as bud eyes. Using these bud eyes is more appropriate for maximum working for changing the rootstocks type for pistachio breeding. A monopodial branch is likewise mentioned as a scion branch. It grows more than one meter relying on the cultivar type and ecological conditions (Tekin et al., 2001).

2.5.7.3 Mixed branch

This branch has not only the fruit but also shoot buds. A noticeably fruit bud that is black and larger is existing on each leaf base, which is on the lower part of the branch, as well as a smaller shoot-bud, in comparison with the fruit bud, is existing on each leaf-base on the upper-part of the branch. There will be five (5) fruit- buds. The other buds are shoot-buds. The branches, which have vegetative and generative developments are of maximum significance, in which these branches possibly will grow upto 80 cm (Tekin et al., 2001).

2.5.7.4 Sympodial branch

These branches have only one fruit-bud on each leaf-base. A terminal bud is present on the tip of the branch; in which it is the shortest pistachio branch. It may possibly grow upto 5 to 20 cm according to the cultivar and ecological conditions.

The swelling of the lateral axillary flower buds on the one-year-old sapling begins at the end of March. By the first two weeks of April, 100 or 300 flowers per paniculata rachis pollinate and bloom. In the course of the equilibrium of April and May the endocarp (nut shell), but not the seed (nutmeat), non expand. Through this time the endocarp is soft and undefended to insect attack and the splitting that appears to be a result of rain. In June the endocarp (nut shell) hardens, and from late June through early August the seed enlarges until it fills the bark. The seed ripens at the end of August and during September. the vertical seam on the long side of the shell splits, the stem deforms and the seed begins to grow

Bark growth is concurrent with shoot growth. The beginning of growth begins in late April and ends near the end of May. New shoot growth produces lateral flower buds in the axilla and often pinnately compound leaves with a single apical vegetative bud. The differentiation of the buds takes place in April, May and June, after this differentiation, a period of stagnation is observed in July, August and September, and by October the differentiation of the buds continues. Occasionally, at the end of June, an additional stream of shoot growth appears on the plant. This growth especially contributes to the production of vegetative side buds, in contrast to the flowering buds produced in the Spring. By August, the leaves, away from the heavy fruit clusters, usually begin to die off noticeably and show aging. Most of the leaves begin to fall at the end of November and the tree will remain dormant until the next March. It is observed that as trees mature, their strong apical dominance becomes more pronounced. (Ferguson et al., 2005).

2.6. Pistachio Cultivars and Important Characteristics Thereof:

Pistachios can be divided into 3 groups depending on the size and shape of the fruits (Tekin and Akkök, 1995; Erdoğan, 2014). These divisions are:

2.6.1 Long group

This group is originated from Turkey, and it is the most frequently grown cultivar type, which is the preferred cultivar of people in Turkey because it is extremely tasteful. The main cultivars of this group (Tekin et al., 2001):

- A- Uzun (creates 60 percentage of Turkey overall production).
- B- Kırmızı (is ranked the 2nd in total production).
- C- Halebi (has a low share in total production. It is suitable for consuming as fresh).
- D- Barak yıldızı (this is one of the earliest cultivars).

2.6.1.1 Important features of the long group:

- A- Cultivars that have a green kernel are used as a raw material in making baklava, icecream as well as dessert industry are involved in this long group. They, in addition, have high rich aroma (Tekin et al., 2001).
- B- Early cultivars that are suitable to be consumed freshly (Barak yıldızı and Halebi).
- C- They have very rich aroma as well as green kernels.
- D- They also have thin-shells, which in turn are proper for processing.

2.6.2 Oval group

This group is originated from Turkey, and it was in recent times developed with higher yields as well as higher quality. Due to the fact that, this group has a higher economic values in the marketing and can provide greater yields, in comparison to other pistachio cultivars. Producer's demand is extraordinary for these cultivars of pistachio. The most significant 2 cultivars are Tekin and Siirt. Siirt cultivar is mostly grown in Siirt Provence (This cultivar is chosen to be used in this study). It sets up around 9 percentage of Turkey's pistachio yield. Whereas, the Tekin cultivar was lately developed as a clone of the cultivar of Siirt with properties of high quality and yield, late blooming, and tolerant to heat.

This cultivar is highly demanded by farmers in both Şanlıurfa and Gaziantep Provinces. These cultivars are mostly used in new-plantations. Tekin cultivar, that was developed recently, competes with the USA and Iran, the highest pistachio producer worldwide, cultivars owing to its inferior predisposition to periodicity and higher rates of natural splitting while on the tree as well as higher yields and qualities (Tekin et al., 2001). In a research that compared the of pistachio cultivars performance under irrigation conditions, the long cultivars produced 104 kg / decare, while the Tekin cultivar that was lately registered, produced 232 kg / decare because of average yield contrast of the trees with the age between 12 - 16 (Bilgel, 2012).

Its splitting rate may possibly increase upto 96 percentage with irrigation. The higher rates of normal splitting of the nuts of pistachio is an essential quality indicator. Pistachio's shell can split when endocarp dehiscence happens at the apex of the suture line, as the kernel is fully-developed. There is a large kernel in the oval group and the production is nearly 43 to 44 percentage; whereas, the production is about 38 to 41percentage in the long group.

2.6.2.1 Important characteristics of the oval group

A- These group pistachios are flamboyant and large, appropriate for consumption as dried-nuts. They contain a red, dry shell, and a fruit size equals to 75 fruits for 100 grams. Whereas, the fruit size in the long groups is 90 to 100 fruits per 100 grams (Tekin et al., 2001).

B- The splitting rate (endocarp dehiscence from the top in the direction to the lower part of the suture-line) is high and almost more than 90 percentage, while the splitting rate is 60 percentage as a mean of long group.

C- The splitting interval is large, which is 3 mm and even higher, which is one of the preferred characteristics in export.

D- The yield is high, and can provide higher incomes / unit-area. Yield increases regularly under irrigation in comparison with the older cultivars.

E- The endocarp is white.

On the other hand, the most significant disadvantage of this group is the endocarp is slightly thicker, compared to the long groups. Nevertheless, this group has a higher kernel-yield and splitting rates because they can form flesh fruit.

2.6.3 Round group:

This group contains Kerman that is grown in the United States of America, and some Iranian types include Akbari, Kellegochi and Owhadi. This group can be cultivated in Turkey as well. Depending on Tekin et al. (2001), this group has less aroma as well as less formation of green color, compared to the cultivars that are grown in Turkey; consequently, this pistachio cultivare is not very welcomed by Turkish people. That is the reason they are cultivated in restricted amounts in Turkey.

2.7 Ecological Requirements:

The strong root structure of pistachios is a significant characteristic, which reduces selectivity of soil. Thus, pistachios have been grown in 3rd and 4th class soils. Pistachio develops magnificently on loamy and partially calcareous soils at a pH more than 7, which would be around 8. Like other fruit types, pistachios can, in addition, grow on sandy-loam, clay-loam, deep and partially calcareous soils and noticeably deliver higher yields (Tekin et al., 1985). In recent times, pistachios have been moved to the lowermost lands particularly in Şanlıurfa and Gaziantep, and have started the cultivation in larger plantations. Pistachios do not cultivate in areas that have high ground-water levels. Pistachio roots will decay in water that is still, because its roots drive deep in soil.

Pistachios are sensitive to the climate because they do not grow in all climates. They need a long with hot summers and low humidity to grow. Majority (about 90 percentage) of the flower-buds of pistachio are damaged when scions were seized at the temperature of -15 °C for the duration of 4 hours in the winter season. During the blooming period in the spring season, 30 percentage of the flowers were damaged at the temperature of -1 °C within only 1 hour, and almost 60 percentage were damaged

within the duration of 2 to 3 hours (Arpacı et al., 2005). In Chico Region which is located in California State in the USA, when temperatures drop to -2.2 to -0.5 °C in the blooming with small fruit periods, were depressingly affected pistachio yield of the year (Joley, 1973). Chilling needs for pistachios is ranged from 750 to 1000 hours (Tekin et al., 1995). It was informed that the requirement of pistachio chilling for Kerman cultivar of the USA is around 1000 hours (Moranto and Crane, 1982). Studies shown that pistachios require a very long with hot and sunny summers for approximately 4 months post-fertilization (Kuru and Ayfer, 1984).

The weather that are cool and rainy and lasts long times in the blooming period can have negative affects on the pollen spread. It can cause an absence in both parthenocarpy as well as fertilization (Okay, 2014). Kanber et al. (1990) reported in their research that the yearly water requirements for pistachio trees is from 750 to 800 mm, and they recommended the irrigation upto 110 to 150 cm depth, and hence, providing 120 mm water at every single irrigation with 20 to 30 day pauses in the summer. Furthermore, a study of Kanber et al. (2000) described that photosynthetic rate was 32 percentage higher, while periodicity was lower, and production was higher in pistachio trees that were provided with satisfactory irrigation and proper timing in comparison with the trees that were not irrigated. Irrigated water must not be supplied to root collar because this may possibly has damages to the vascular bundles.

3. MATERIALS and METHODS

3.1. Materials

In this study, both the fruits and the characteristics of tree and leaf structures of 4 different pistachio varieties or types grown in Duhok region in Northern Iraq will be determined. These are; Abas Ali (Figure 3.1.), Ahmad Aghaye (Figure 3.2.), Malta (Figure 3.3.), and Siirt (Figure 3.4.). All of them grown in Duhok under irrigated similar conditions. The trees were in yielding age approximately 20 or 25 years old. The climatical data were given Table 3.1.

Table 3.1. The maximum and minimum temperature in Duhok (2014-2020 years)

Months	Temp.	2014	2015	2016	2017	2018	2019	2020	AVERAGE
January	Max.	13	12	9.9	11	13	12	11	11.7
	Min.	4.4	3.7	2.4	2.2	4.8	4.0	3.2	3.5
February	Max.	15	14	16	13	15	14	12	14.1
	Min.	4.5	5.4	6.9	2.3	6.6	5.3	4.2	5.0
March	Max.	19	18	18	17	22	15	19	18.3
	Min.	9.7	8.2	8.7	8.6	11.0	6.9	9.4	8.9
April	Max.	24	23	25	23	25	20	23	23.3
	Min.	14	12	14	12	13	10	12	12.4
May	Max.	31	31	30	31	29	31	31	30.6
	Min.	19	18	18	17	18	18	18	18.0
June	Max.	37	36	37	37	36	39	37	37.0
	Min.	22	22	24	22	22	24	22	22.3
July	Max.	40	42	41	42	41	40	42	41.1
	Min.	26	26	26	26	26	24	28	26.0
August	Max.	41	40	42	42	40	42	40	41.0
	Min.	26	26	27	26	25	26	25	25.9
September	Max.	34	37	34	38	37	36	39	36.4
	Min.	21	23	21	23	22	21	24	22.1
October	Max.	26	28	29	28	29	30	32	28.9
	Min.	16	18	16	15	18	17	17	16.7
November	Max.	18	18	20	15	18	21	21	18.7
	Min.	8.7	8.6	7.7	9.8	10.0	8.8	11.0	9.2
December	Max.	14	13	11	17	13	15	16	14.1
	Min.	6.8	3.9	3.6	6.9	7.1	7.3	5.4	5.9



Figure 3.1. Abas Ali tree and fruits



Figure 3.2. Ahmad Aghaye tree and fruits



Figure 3. 3. Malta tree and fruits



Figure 3. 4. Siirt tree and fruits

3.2. Methods

The phenological, pomological and morphological characteristics of the cultivars and genotypes included in this study were carried out using the pistachio descriptors IPGRI (International Plant Genetic Resources Institute) and UPOV (The International Union for the Protection of New Varieties of Plants).

3.2.1. Morphological features

3.2.1.1. Growth habit; The crown shapes of the pistachio genotypes and varieties included in the experiment, Observationally evaluated as "Erect", "Semi-erect", "Spreading" and "Drooping" as given in 3.5.

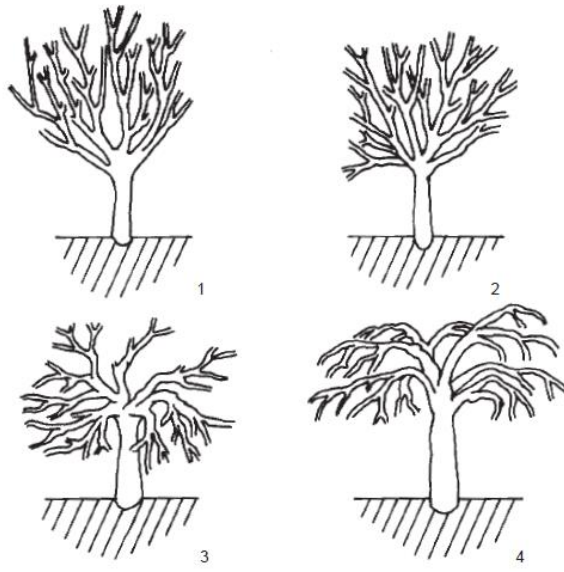


Figure 3. 5. Tree crown shapes

3.2.1.2. Branching situation; By observing the branching status according to the IPGRI descriptor; It will be determined as 'Sparse', 'Intermediate' and 'Dense'.

3.2.1.3. Leaf length (cm); With 3 Replications and 10 leaves in each repetition, Measured from the base of petiole to the tip of terminal leaflet with a ruler as shown Figure 3.6. (Yalcin, 2020).

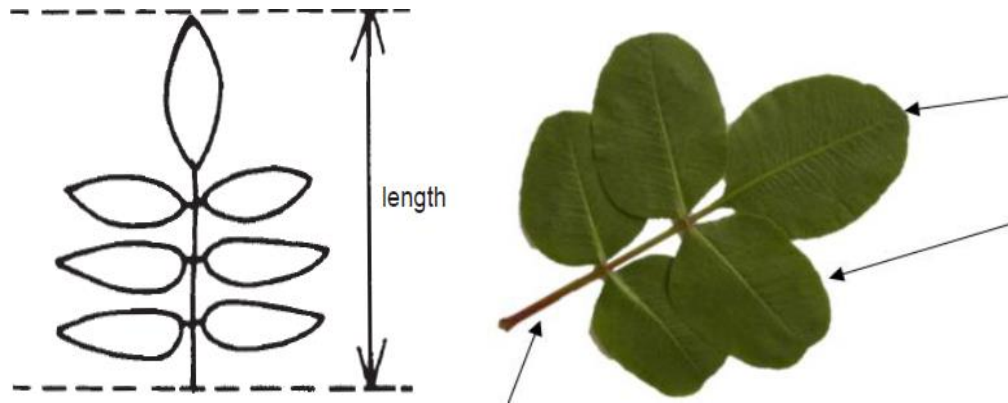


Figure 3. 6. Leaf length

3.2.1.4. Leaf width (cm): It will be determined by measuring with a ruler from the widest part of the leaf blade in 3 replications and 10 leaves in each repetition (Fig. 3.7.) (Yalcin, 2020).

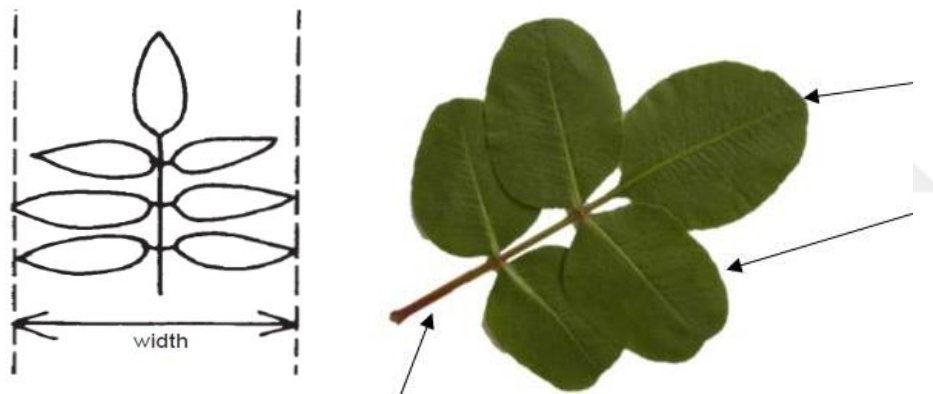


Figure 3. 7. Leaf width

3.2.1.5. Terminal leaflet length and width (cm); The length and width of the farthest leaf will be determined in 3 Replications, and in each repetition, 10 leaves from the stem to the tip and the widest part will be measured with a ruler (Fig. 3.8.).



Figure 3. 8. Terminal leaf length and width

3.2.1.6. Terminal leaflet shape: Terminal leaflet shape observed according to IPGRI descriptor. As Figure 3.9.

Broad lanceolate 1

Elliptic 2

Ovate 3

Round ovate 4

Roubdish 5

Other 6

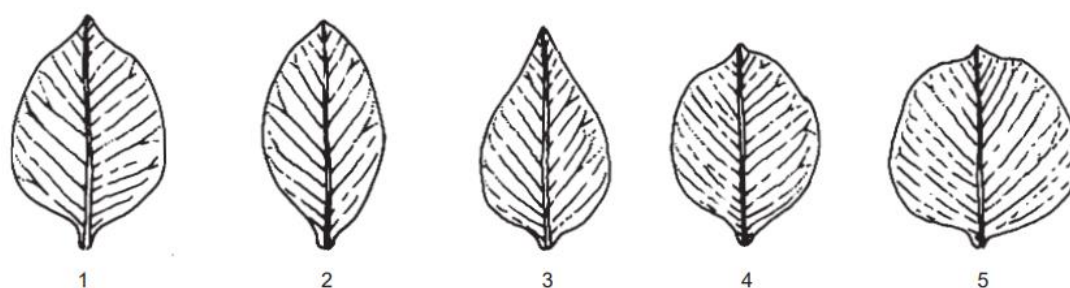


Figure 3. 9. Terminal leaflet shape

3.2.1.7. Terminal leaflet apex; Terminal leaflet shape observed according to IPGRI descriptor. As Figure 3.10.



Figure 3. 10. Terminal leaflet apex

3.2.1.8. Terminal leaflet base; Terminal leaflet base observed according to IPGRI descriptor. As Figure 3.11.

Attenuate 1

Obtuse 2

Truncate 3

Oblique 4

Other 5

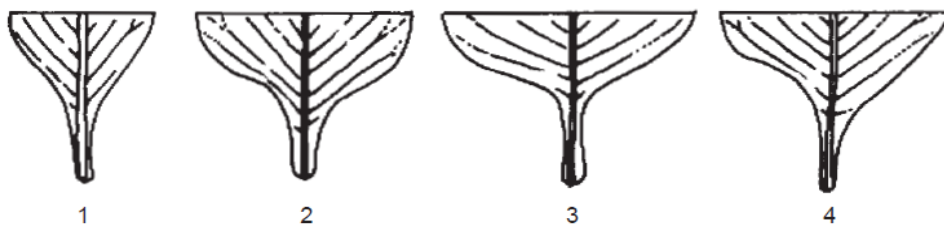


Figure 3. 11. Terminal leaflet base

3.2.1.9. Leaf colour: Evaluated at adaxial side, at time when shoot is woody, before harvest time by IPGRI descriptor. They are evaluated as;

Light green 1

Green 2

Dark green 3

3.2.1.10. Female flower bud shape; The shape of the female flower bud according to the IPGRI descriptor Figure 3.12. Based on observational basis; It has been evaluated as "wide oval (1)", "narrow oval (2)" and "conical (3)".

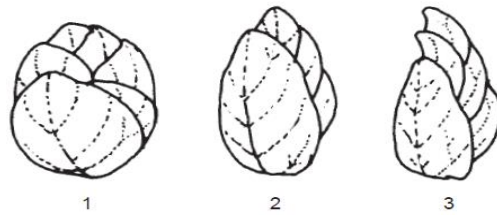


Figure 3. 12. Female flower bud shape

3.2.1.12. Female flower bud color; The color of the female flower bud was observational; It is rated as "Red brown", "Light brown", "Brown" and "Dark brown".

3.2.1.13. Flowering time

Begining of Flowering; when open 5 % of all of fowers.

Full Flowering; when open over 50 % of all of fowers.

End of Flowering; when open of all of flowers.

3.2.2. Some physical feature

Empty fruit rate (%); In the harvested fruits, 3 replicates and 50 in each replication were counted and expressed as %.

Shell Splitting Rate (%); In harvested fruits 3 replicate and 50 in each replication, splitted fruits were determined by counting and expressed in%.

Suture opening (mm); The cracking made by the hard shell on the fruit was measured with 3 replications and a 0.01 mm precision digital caliper on 25 fruits in each repetition.

Hard Shell (Endocarp) Thickness (mm): Hard Shell thickness was measured with 3 replications and a 0.01 mm precision digital caliper on 10 fruits in each replication.

Aroma of Kernel; According to the IPGRI descriptor, the Kernel flavor of the genotypes in the experiment was sensory; It was rated as "satisfactory" and "unsatisfactory".

Kernel Colour; Internal fruit color of the genotypes in the experiment was determined by observing according to the IPGRI descriptor.

1. yellowish
2. Yellowish green
3. Green
4. Other

Color of Testa; The color of the Kernel peel of the cultivars and genotypes included in the experiment was determined according to UPOV and IPGRI by observation.

1. Grayish
2. Reddish
3. dark red
4. Purplish UPOV (2016)
5. Other

3.2.2. Pomological analysis

Homogeneity of fruit crust (exocarp) color; The homogeneity of the fruit skin color in the varieties and genotypes included in the experiment was determined by observation and based on Figure 3.13.

Homogeneous 0

Inhomogeneous 1

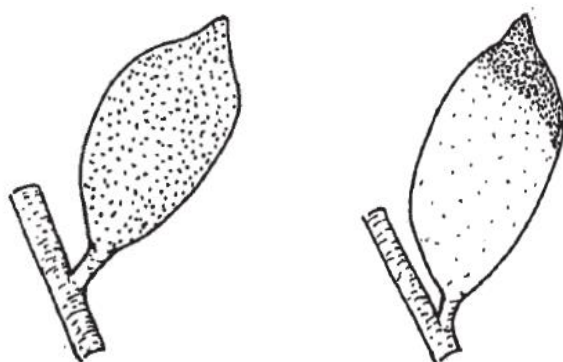


Figure 3. 13. Homogeneity of fruit skin (exocarp) color

Hull Colour; The color of the outer skin of the fruit in the cultivars and genotypes included in the experiment was determined by observing the UPOV descriptor.

- Light cream 1
- Yellow white 2
- Orange white 3
- Orange red 4
- Red 5
- Red purple 6

Nut shape; Fruit shapes in the varieties and genotypes included in the experiment were determined according to the IPGRI descriptor by dividing the fruit length by the fruit width as shown in Figure 3.14. and by observing.

- 1st Round ($l / w < 1.5$)
- 2. Oval ($1.5 < l / w < 1.8$)
- 3. Long ($l / w > 1.8$)
- 4. Narrow heart shaped
- 5. Heart shaped

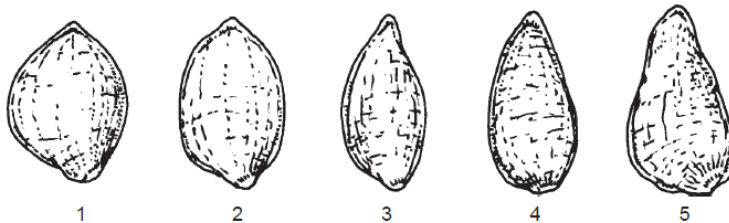


Figure 3. 14. Fruit shape scale

Depression of Shell near pedicel scar; In the varieties and genotypes included in the experiment, the crust collapse from the fruit stem part was determined by looking at the front and lateral views of the shell, as shown in Figure 3.15.- 3.16.

- Absent 0
- Slight 1
- Pronounced 2

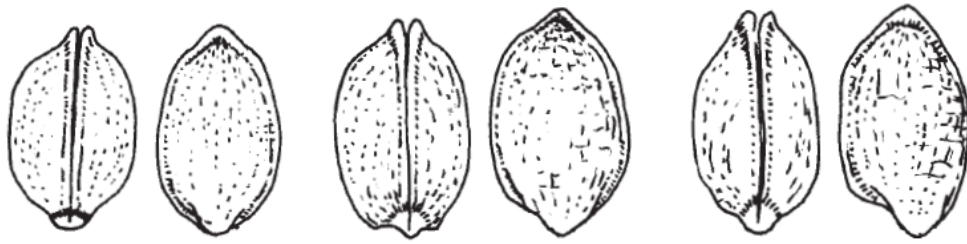


Figure 3. 15. Front and lateral view of shell



Figure 3. 16. The shape of the shell depression in the fruit stem part

Pedicle Scar Shape; Denemede yer alan çeşit ve genotiplere ait meyvelerin The shape of the crust on the fruit stem was determined by observing the IPGRI descriptor.

Globe 1

Oval 2

Elliptical 3

Thin tall 4

Other 5

The height of the shell on the fruit stem; The height of the peel in the fruit stem part of the fruits belonging to the varieties and genotypes included in the experiment was determined by observing as given in Figure 3.17. according to the IPGRI descriptor.

1. Flattened

2. Protruding

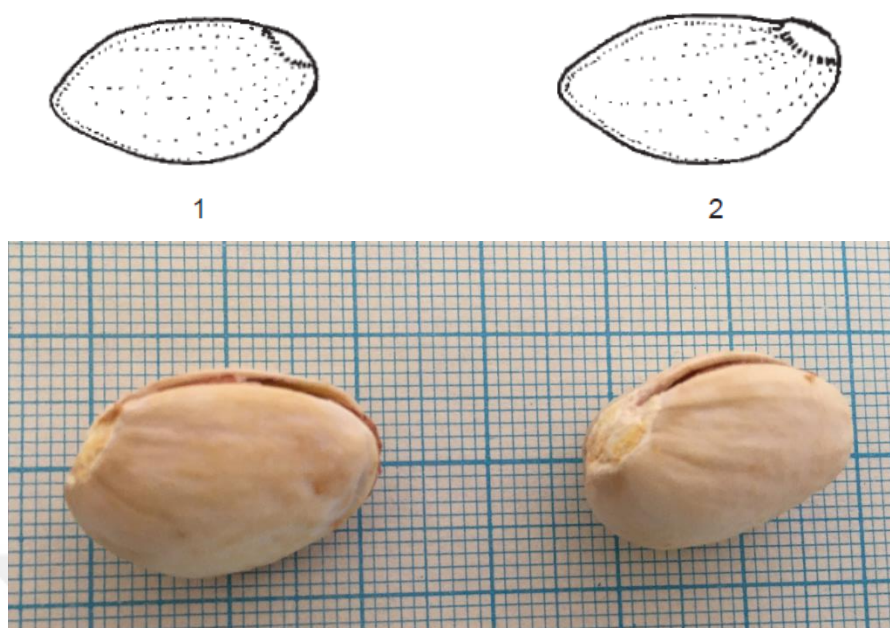


Figure 3. 17. The height of the shell in the fruit stem

Suture height: Suture height of cultivars and genotypes was determined by observing as in Figure 3.18.

Low 3

High 7

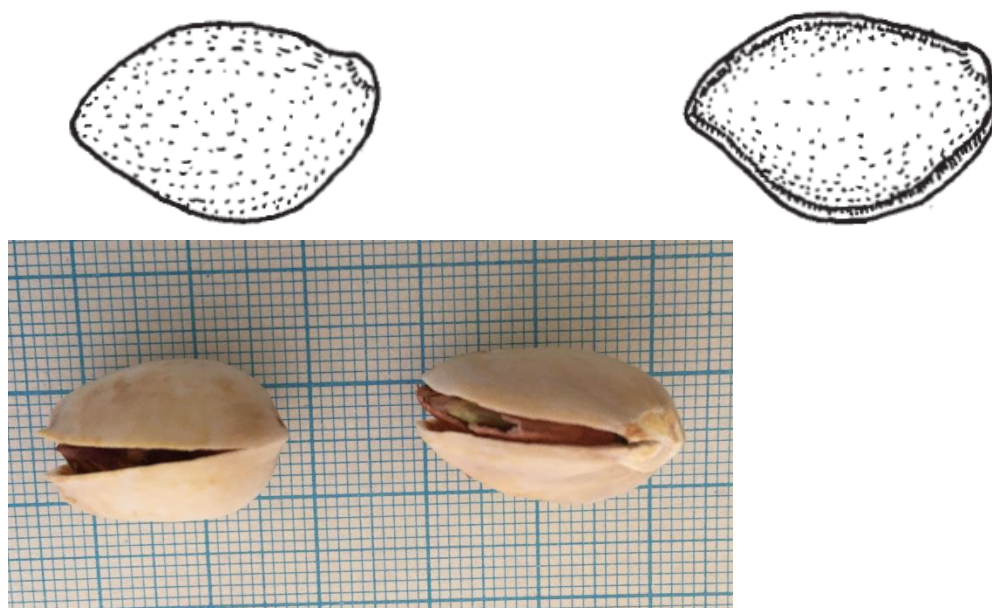


Figure 3. 18. Nut suture height

Hard shell color; The hard skin color of fruits has been evaluated as "Bone" and "Dark bone" (Kuru, 1993).

Snap level; Fruit crack was evaluated according to the IPGRI descriptor by observing "slightly cracked" and "cracked"

Snap level; Fruit crack was evaluated according to the IPGRI descriptor by observing "slightly cracked" and "cracked". (Fig.3.19.).

1. Back side only
2. Abdominal side
3. Back and abdomen



Figure 3. 19. Snap positions of fruit peels

Snap (suture opening); The cracking of the hard shell in the fruit was evaluated subjectively according to the descriptors of IPGRI and UPOV as given in Figure 3.20.

- Narrow 3
- Medium 5
- Wide 7



Figure 3. 20. Suture opening

Ease of shell breaking; Ease of shell breakage in the varieties and genotypes included in the experiment was determined by observing according to the IPGRI descriptor.

Easy 3

Medium 5

Difficult 7

Fruit length (mm); In 3 replications and in each repetition, 25 fruits were measured from the farthest points along the fruit axis with a digital caliper with 0.01 mm precision as shown in Figure 3.21.

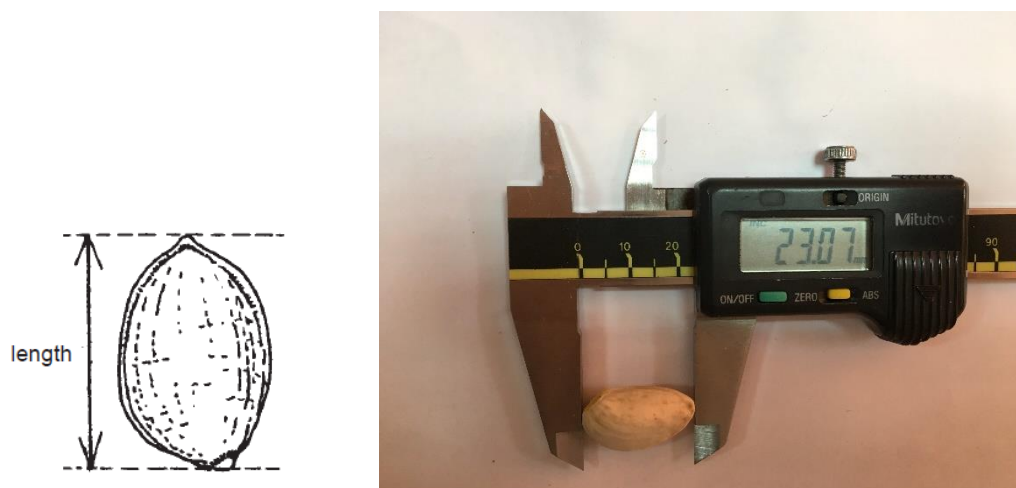


Figure 3. 21. Fruit length

Fruit width (mm); In 3 replications and in each repetition, 25 fruits were measured from the widest points perpendicular to the fruit with a digital caliper with 0.01 mm precision as shown in Figure 3.22.



Figure 3. 22. Fruit width

Fruit thickness (mm); 3 replications and 25 fruits in each repetition were measured from the widest part of the suture with a digital caliper with 0.01 mm precision as given in Figure 3.23.



Figure 3. 23. Fruit thickness

Average fruit weight (g); It was obtained by weighing 25 fruits in 3 replications and each repetition on a scale sensitive to 0.01 g (Figure 3.24.) and taking their average.



Figure 3. 24. Average fruit weight

100 grain weight (g); With 3 replications and each sample, 100 shelled fruits were determined by weighing them with a precision balance sensitive to 0.01 g (Figure 3.24.).

Kernel length (mm); It was measured with a digital caliper with 0.01 mm precision from the farthest points along the seed axis of 25 Kernels with 3 replications and in each repetition as given in Figure 3.25.



Figure 3. 25. Kernel fruit length

Kernel width (mm); In 3 replications and each iteration, 25 internal fruits were measured from the widest point with a digital caliper with 0.01 mm precision as given in Figure 3.26.



Figure 3. 26. Kernel width

Kernel thickness (mm); It was measured with a digital caliper with 0.01 mm precision from the widest point perpendicular to the cotyledon suture of 25 Kernels with 3 replications and in each repetition as given in Figure 3.27.



Figure 3. 27. Kernel thickness

Kernel weight (g); It was obtained by measuring and averaging the scales individually with 3 replications and sensitive to 0.01 g for 25 pieces in each repetition.

Shelling Percentage (%); Internal fruit yield was obtained by multiplying the ratio of fruit core to shelled fruit by 100. During this analyzes all part of fruits (Figure 3.28.) were calculated.



Figure 3. 28. The part of fruits which are weighted

$$\text{Shelling Percentage (\%)} = \frac{\text{Kernel weight}}{\text{Fruit Weight}} * 100 \quad (3.1.)$$

100 Kernel weight (g); It was obtained as a result of weighing 100 internal fruits in 3 replications and in each repetition with a precision scale sensitive to 0.01 g.

3.2.3. Determination total fatty acid contents

Fatty acid contents were determined. After the extraction process in the Soxhlet device, the hexane was evaporated in the vacuum evaporator and the amount of oil obtained was calculated as % (American Oil Chemists' Society, 1990).

3.2.4. Determination of fatty acid compositions

Pistachio kernels separated from their shells were reduced to 0.3-0.5 mm by subjecting them to size reduction with a waring blender. Oil was extracted from the reduced size almonds by using petroleum ether using the Soxhlet method. After the extraction, the solvent was removed using a rotary vacuum evaporator. Pistachio oil was esterified using 10% (v/v) $\text{BF}_3\text{-MeOH}$ in accordance with AOCS (1989). Fatty acid methyl ester (FAME) obtained as a result of the process was dissolved in CHCl_3 and fatty acid determinations were made using Thermo Quest CE GC-MS. The application conditions are as follows; carrier gas, helium; flow rate 1 ml/min, FID (flame ionization detector) temperature, 250 °C; split ratio, 100:1; flow rate 20 ml/min; column, Supelco sp-2330 (fused silica capillary column, 30mx0.25mmx0.2 μm). The peaks obtained were identified by comparison with the original samples according to their arrival time (Aslan et al., 2002; Yakar et al., 2021).

3.3. Statistical Analyzes

In the research, it was explained in methods part of this thesis different number of fruits were analyzed to different features. However, each calculation was considered three replications. Observation was made according to IPGRI and UPOV criterias. The difference of average of between cultivars were determined using LSD (Least Significant Difference) test. Standard deviations were calculated some of data.

4. RESULTS and DISCUSSION

4.1. Some Morphological Features

4.1.1. Growth habit and branching situations:

According to visual observations, the cultivars are changed as Table 4.1.

Table 4. 1. Growth habit and branching

Cultivars	Growth habit	Branching
Abas Ali	Erect	Sparse
Ahmad Aghaye	Semi Erect	Intermediate
Malta	Drooping	Sparse
Siirt	Semi Erect	Dense

Growth habit is changed of each cultivars according to Table 4.1. When it is observed as branching Abas Ali and Malta cultivars accepted 'Sparse' type.

4.1.2. Leaf properties

Some leaf properties were determined that used pistachio cultivars. Leaf length and width and ratio were calculated. The obtained data were given Table 4.2.

Table 4. 2. Some leaf properties of different pistachio cultivars grown in Northern Iraq

Cultivars	Leaf Length (cm)	Leaf Width (cm)	Leaf Length/ width	Pedicle Length (cm)
Abas Ali	16,20±1,835	13,51±1,479	1.199	3.70±1,136
Ahmad Aghaye	18,81±2,150	17,46±1,727	1.077	5,50±1,582
Malta	17,25±3.391	16,21±2,992	1,064	4,70±1,388
Siirt	19,41±3,069	20,18±3,759	0,961	4,88±1,508
Mean	17,92	16,84	1.075	4.70

According to Table 4.2., The highest Leaf length is obtained from Siirt cultivar. Abas Ali is the smallest one. About Leaf width the biggest is Siirt cultivar while Abas

Ali the small one. The ratio of width and length Abas Ali the biggest when compared the others. When it is considered as petiole length the biggest (5.50 cm) is Ahmad Aghaye.

The leaflet of each cultivar properties also determined. The Leaflet properties was given Table 4.3.

Table 4. 3. Some leaflet properties of different pistachio cultivars grown in North Iraq

Cultivars	Leaflet Length (cm)	Leaflet Width (cm)	Leaflet length/width
Abas Ali	8,65±0,811	5.81±0,713	1,488
Ahmad Aghaye	10,08±1,459	6,43±1.070	1,567
Malta	9,23±1,693	6,55±0,828	1,409
Siirt	10,93±1,852	7,26±1,329	1,505
Mean	9.72	6.51	1.493

According to Table 4.3., Length of leaflet 10,93 with Siirt Cultivar and the small is Abas Ali 8.65 cm. The similar results were also obtained from Leaf width. The ratio was changed. The highest value is obtained from Ahmad Aghaye.

The terminal leaflet Shape, leaflet apex and base and leaf colour were determined and all observations were given Table 4.4. and Figure 4.1.

Table 4. 4. Subjective leaflet properties of different pistachio cultivars

Cultivars	Terminal Leaflet Shape	Terminal Leaflet Apex	Terminal Leaflet Base	Leaf Colour
Abas Ali	Broad lanceolate	Obtuse	Truncate	Light green
Ahmad Aghaye	Ovate	Mucronate	Obtuse	Green
Malta	Round ovate	Mucronulate	Truncate	Light green
Siirt	Elliptic	Acumminate	Truncate	Green

The cultivars' terminal leaflet shape, apex, base and leaf colours are different to each other. The list determined according to IPGRI evaluations.

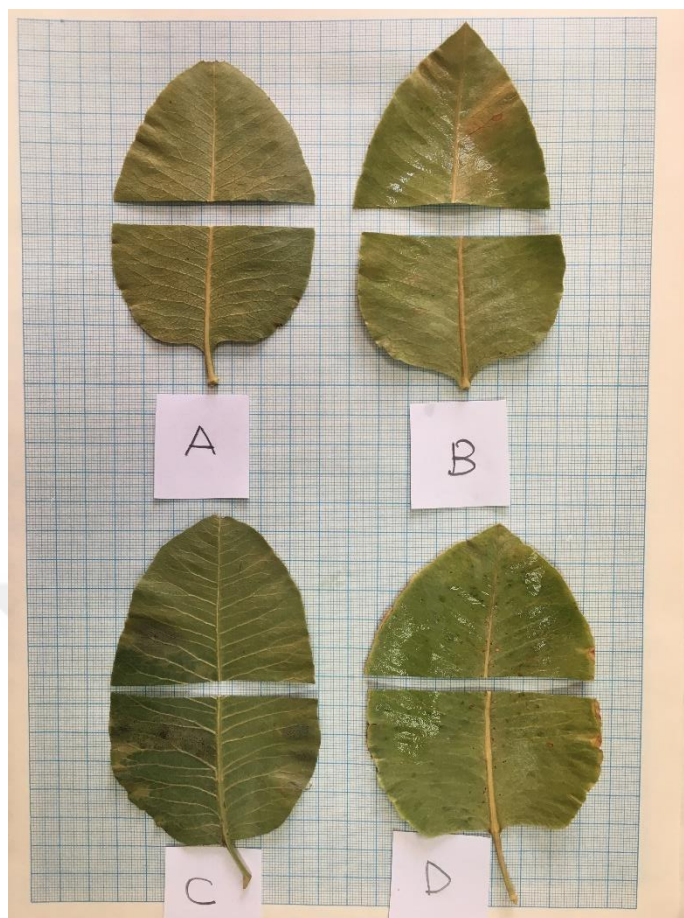


Figure 4. 1. Terminal leaflet (A: Abas Ali, B: Ahmad Aghaye, C: Siirt, D: Malta)

4.2. Some Inflorescence Features

Female flower bud shape and colour was determined and given Table 4.5 and Figure 4.2.

Table 4. 5. Some Female flower bud shape and colour of different pistachio cultivars grown in North Iraq

Cultivars	Female flower bud shape	Female flower bud colour
Abas Ali	wide oval	Red brown
Ahmad Aghaye	narrow oval	Light brown
Malta	conical	Brown
Siirt	conical	Dark brown

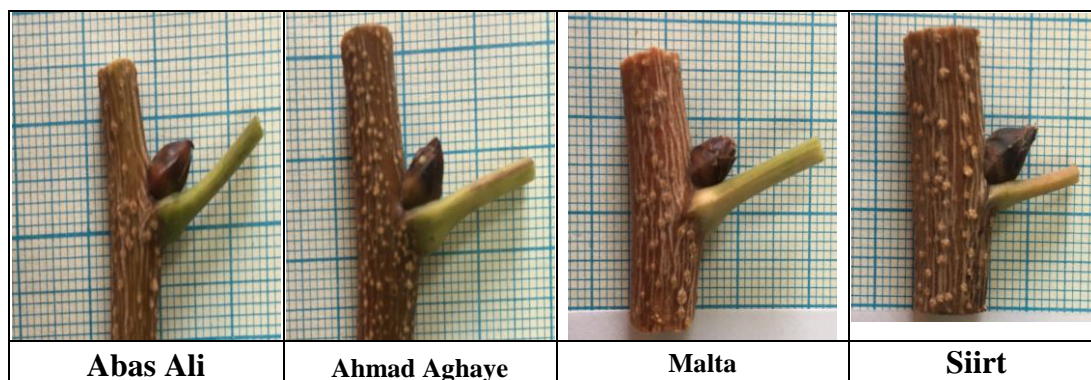


Figure 4. 2. Flower buds of cultivars

As it was seen Table 4.5., Malta and Siirt cultivars considered as ‘conical’ bud shape. Abas Ali ‘wide oval’ and Ahmad Aghaye considered as ‘narrow oval’.

The flowering time is also determined of cultivars. Phenological observations were given Table 4.6.

Table 4.6. Phenological observations on flowering time of different pistachio cultivars grown in North Iraq in 2020

Cultivars	Begining of flowering	Full Flowering	End of Flowering
Abas Ali	10 April	17 April	25 April
Ahmad Aghaye	8 April	16 April	23 April
Malta	6 April	15 April	25 April
Siirt	5 April	18 April	26 April

According to flowerind date as full flowering time, the earliest is Malta later Ahmad Aghaye. The late cultivar is Siirt. But general consideration was all of them similar or nearer time they opened flowers.

4.3. Some Physical Features

After harvesting all fruits were sun dried with hull. Splitting, unsplitting, total fulfilled and blank fruits are determined (Table 4.7.).

Table 4.7. Some physical traits of different pistachio cultivars grown in North Iraq

Cultivars	Splitted Fruit (%)	Unsplitted Fruit (%)	Unsplitted but filled Fruit (%)	Blank Fruit (%)	Totally filled nuts (%)
Abas Ali	82,4±2,61	17,6±2,61	12,8±3,90	4,8±1,79	95,2±1,79 ab
Ahmad Aghaye	79,6±3,58	20,4±3,58	16,8±4,56	2,6±1,94	97,4±1,94 a
Malta	78,8±6,09	21,2±6,09	14,8±5,93	6,4±1,67	93,6± 1,67 b
Siirt	82,0±6,32	18,0±6,32	12,8±6,41	5,2±2,28	94,8±2,28 b
Mean	80,7	19,3	14,3	3,5	95,25

According to Table 4.7., the highest (82.4 %) splitting rate was obtained from Abas Ali. The lowest one is Ahmad Aghaye. But all the data according to Table 4.7. Statistically non- important. Blank fruit was very low. The lowest (2.6 %) Ahmad Aghaye. Totally filled fruit nuts was over 90 percent.

In these cultivar, Suture opening (mm), endocarp thickness (mm), aroma of kernel, testa colour and Kernel colour were determined (Table. 4.8.)

Table 4.8. Suture opening, endocarp thickness and Some other traits of different pistachio cultivars grown in North Iraq

ÇEŞİTLER	Suture Opening (mm)	Endocarp Thickness (mm)	Aroma of Kernel	Kernel Skin (Testa) Colour	Kernel Colour
Abas Ali	1,30±0,519	0,75±0,030	Satisfactory	Deep red	Yellowish green
Ahmad Aghaye	1,88±0,555	0,88±0,070	UnSatisfactory	Reddish	Yellowish
Malta	3,18±0,699	0,78±0,070	Satisfactory	Deep red	Yellowish green
Siirt	2,10±0,275	0,86±0,035	Satisfactory	Reddish	Yellowish
Mean	2,11	0,81	--	--	--

Suture opening is measured by 0.01 mm precision digital caliper as mm. Obtained results were given Table 4.8. Between the cultivars the best one is Malta. It was 3.18 mm open space. Endocarp thickness also changed between 0.75 to 0.88 mm. Malta and abas Ali kernel colour was similar.

4.4. Some Pomological Features

Hull Colour Homogeneity; The homogeneity of the fruit skin color in the varieties and genotypes included in the experiment was determined by observation. Only Ahmad Aghaye is homogenous.

Mesocarp Colour; The color of the outer skin of the fruit in the cultivars and genotypes included in the experiment was determined by observing the UPOV descriptor. It was observed as below.

Yellow -White; Ahmad Aghaye

Yellow-orange: Siirt

Orange red; Abas Ali

Red purple; Malta

Fruit shape; Fruit shapes in the varieties and genotypes included in the experiment were determined according to the IPGRI descriptor by dividing the fruit length by the fruit width as and by observing.

1st Round ($l / w < 1.5$): Malta

2. Oval ($1.5 < l / w < 1.8$): Siirt, Abas Ali

3. Elongated ($l / w > 1.8$): Ahmad Aghaye

Depression of Shell near pedicel scar; In the varieties and genotypes included in the experiment, the crust collapse from the fruit stem part was determined by looking at the front and lateral views of the shell, as shown in Figure 3.32. Malta, Siirt and Ahmad Aghaye are absent, Abas Ali have slight pedicel scar.

Pedicel Scar Shape; The shape of the crust on the fruit stem was determined by observing the IPGRI descriptor.

Globe: Malta

Oval: Abas Ali, Siirt and Ahmad Aghaye

The height of the shell on the fruit stem; The height of the peel in the fruit stem part of the fruits belonging to the varieties and genotypes included in the experiment was determined by observing as given IPGRI descriptor.

1. Engrave: Malta, Abas Ali, and Siirt
2. Protruding: Ahmad Aghaye

Suture height; Suture height of cultivars and genotypes was determined as below.

- Low: Abas Ali and Ahmad Aghaye
High: Malta and Siirt

Hard shell colour; The hard skin color of fruits has been evaluated as "Bone" and "Dark bone" (Kuru, 1993).

- Bone: Ahmad Aghaye, Malta and Abas Ali
Dark Bone: Siirt

Openin level; Fruit crack was evaluated according to the IPGRI descriptor by observing "slightly cracked" and "cracked". Only Malta is cracked. The others are Slightly Cracked.

Snap (suture opening); The cracking of the hard shell in the fruit was evaluated subjectively according to the descriptors of IPGRI and UPOV as given in Figure 3.38.

- Narrow: Siirt and Abas Ali
Medium: Ahmad Aghaye
Wide: Malta

Ease of shell breaking; Ease of shell breakage in the varieties and genotypes included in the experiment was determined by observing according to the IPGRI descriptor.

- Easy: Malta and Ahmad Aghaye
Medium: Abas Ali
Difficult: Siirt

The traits of nuts were determined and given Table 4.9.

Table 4. 9. Some pomological traits of different pistachio cultivars with endocarps grown in North Iraq

Cultivars	100 Nut Weight (g)	Nut Weight (g)	Nut length (mm)	Nut Width (mm)	Nut Thickness (mm)
Abas Ali	123,7	1,237+0,050 a	22.22+0,384 a	13,44+0,271 b	10,83+0,202 b
Ahmad Aghaye	111,4	1,114+0,070 bc	20.72+0,297 b	11,92+0,376 c	9,97+0,378 c
Malta	142,1	1.421+0,080 a	20.89+0,846 b	14,23+0,347 a	12,13+0,506 a
Siirt	108,2	1,082+0,090 c	20.20+0,842 c	11,44+0,590 c	10,62+0,143 b
Mean	121,4	1,21	21,00	12,75	10,88
LSD (%5)		0,125	0,429	0,631	0,461

According to Table 4.9., 100 nut weight was highest (142,1 g) value obtained from Malta cultivar. The lowest (108.2 g) value was Siirt cultivar. Nut length, width and thickness also changed among the cultivars. But generally considered that Malta is bigger size than others.

Kernel traits were determined and given Table 4.10.

Table 4. 10. Some pomological traits of kernels different pistachio cultivars grown in North Iraq

Cultivars	100 Kernel Weight (g)	Kernel Weight (g)	Kernel length (mm)	Kernel Width (mm)	Kernel Thickness (mm)
Abas Ali	64,9	0,649+0,043	18,92+0,544 a	10,00+0,449	8,01+0,259 a
Ahmad Aghaye	79,2	0,792+0,530	17,98+0,334 bc	9,28+0,298	7,62+0,255 b
Malta	78,3	0,783+0,054	18,49+0,743 b	11,06+0,254	8,22+0,302 a
Siirt	54,0	0,540+0,033	17,43+0,549 c	8,61+0,341	8,26+0,265 a
Mean	69,1	0,690	18,02	9,73	8,02
LSD (%5)		N.S.	0,815	N.S.	0,492

According to Table 4.10. as considered Kernel of these cultivars, the highest (79,2 g/100 kernel) value determined from Ahmad Aghaye, the lowest (54 g) was Siirt. Kernel length, width and thickness were changed among the cultivars.

In this experiment 100 hull weight and shelling percentages were determined and given Table 4.11.

Table 4. 11. Some weighth and shelling percentages of different pistachio cultivars grown in North Iraq

CULTIVARS	100 Fruit Weight (g)	100 Hull Weight (g)	100 Nut Weight (g)	100 Kernel Weight (g)	Shelling (%)
Abas Ali	153,3	29,6	123,7	64,9	42,33
Ahmad Aghaye	134,7	23,3	111,4	79,2	58,79
Malta	179,0	36,9	142,1	78,3	43,74
Siirt	130,8	22,6	108,2	54,0	41,28
Mean	149,45	28,10	121,35	69,1	46,23

According to Table 4.11., Hull weight was calculated from general fruit weight-nut weight. The highest Hull or red skin (36,9 g) was Malta. In fact, Malta was bigger size. This result is normal. The important point shelling percentage. It is obtained from Ahmad aghaye because of kernel weight was higher (Table 4.10.).

4.5. Determination Total Faty Acid Contents

In the chemical analyzes performed on the fruits taken during the harvest period of some pistachio varieties, when the total oil ratios were examined in Table 4.12., the highest value (56.65%) was determined in Abas Ali pistachio variety, while the lowest value (39.86 %) was determined in Malta variety. Total oil ratios in other varieties varied between these two values.

Table 4.12. Total fat contents of different Pistachio cultivars grown North Iraq

CULTIVARS	TOTAL FAT CONTENT (%)
Abas Ali	56.65
Ahmad Aghaye	53.32
Malta	39.86
Siirt	51.92

These data was similar to Agar et al., (1995). Siirt cultivar is considered similar in this research. The samples were taken from different cities in Turkey. Such as Aydin, Gaziantep, İcel, Manisa and Sanliurfa. The fat content were changed 51.78 % in Sanliurfa while Aydın's samples 55.90 %. The other cities between these numbers.

4.6. Determination of Fatty acid Compositions

Fatty acid composition of different pistachio cultivars which are grown at North Iraq in Duhok province was the determined. The obtain it results were given Table 4.13.

Table 4.13. Fatty acid composition of different pistachio cultivars grown North Iraq

Acid name	Abas Ali	Ahmad Aghaye	Malta	Siirt	AVERAGE	LSD (% 5)
(C18:1n9c) Oleic Acid	63.14±0.27 d	65.19±0.01 c	73.34±0.46 b	74.01±0.18 a	68.92±5.56	0.53
(C18:2n6c) Linoleic Acid	23.67±0.08 a	22.53±0.02 b	14.32±0.05 c	11.61±0.01 d	18.03±5.97	0.09
(C16:0) Palmitic Acid	9.885±0.58 a	8.64±0.04 b	8.88±0.14 b	9.15±0.31 b	9.13±0.53	0.63
(C18:0) Stearic Acid	1.14±0.06 c	1.55±0.03 b	1.58±0.01 b	3.28±0.06 a	1.88±0.94	0.09
(C16:1) Palmitoleic Acid	0.77±0.03 b	0.685±0.00 c	0.82±0.01 a	0.54±0.01 d	0.70±0.12	0.03
(C20:1n9) cis-11-Eicosenoic Acid	0.355±0.06	0.49±0.02	0.45±0	0.52±0.01	0.45±0.07	N.S. (0.06)
(C18:3n3) A-Linolenic Acid	0.425±0.09 a	0.3±0.03 ab	0.33±0.02 b	0.23±0.00 c	0.33±0.08	0.09
(C22:0) Behenic Acid	0.65±0.02 b	0.07±0.00 b	0.07±0.00 b	0.09±0.02 a	0.22±0.29	0.02
(C20:0) Arachidic Acid	0.24±0.15	0.14±0.00	0.13±0	0.24±0.15	0.18±0.06	N.S. (0.14)
(C14:0) Myristic Acid	0.1±0.01 b	0.11±0.00 b	0.14±0.01 a	0.13±0.01 a	0.12±0.02	0.01
(C17:1) cis-10-Heptadecenoic Acid	0.07±0.01 a	0.07±0.02 a	0.09±1.70 a	0.04±0.02 b	0.06±0.02	0.02
(C24:1n9) Nervonic Acid	0.04±0.01	0.045±0.01	0.04±0.01	0.04±0.02	0.04±0.00	N.S. (0.02)
(C17:0) Heptadecanoic Acid	0.03±0.01	0.03±0.01	0.03±0.01	0.04±0.05	0.03±0.01	N.S. (0.02)
(C20:5n3) cis-5,8,11,14,17-Eicosapentaenoic Acid	0.03±0.01	0.03±0.01	0.03±0.01	0.03±0.00	0.03±0.00	N.S. (0.01)

Table is order it from higher to lower contents. All of the result of fatty acid compositions are written. But the most important are Oleic Acid, Linoleic Acid, Palmitic Acid, Stearic Acid and Palmitoleic Acid.

According to Table 4.13., Oleic acid rate was higher (74.01) in Siirt Cultivar, while Abas Ali cultivar lowest. But Abas Ali is higher than others according to Linoleic acid. Palmitic acid is also higher (23.67) in Abas Ali. The lowest number is obtained from Siirt cultivar. Stearic acid is also another important acid for nuts. It was higher in Siirt cultivar. The other acid rate was changed according to cultivar to cultivar. All of the calculated contents can be seen Table 4.13.

These data was similar to Agar et al., (1995). Siirt cultivar is considered similar in this research. In Siirt cultivar which samples from taken from Sanliurfa, Oleic acid was 66.03, Linoleic acid 21.35, Palmitic acit was 9.16.



5. CONCLUSION and RECOMMENDATIONS

5.1. Conclusion

As with other hard-shelled fruit species, pistachio is an important fruit species due to its high nutritional content and economic return. The need for special ecological conditions, the slowness of plant development and the long infertility of youth, the fact that its production is low throughout the world increases its economic importance and its contribution to the producer and country's economy is high.

The fact that pistachio can be grown in marginal areas such as barren, arid, calcareous, stony and rocky areas where other fruit types cannot be grown economically increases the importance of this fruit type. In this study, the herbal and fruit characteristics of 4 different varieties in Pistachio orchards in Duhok region in the North of Iraq were examined. While evaluating these data, phenological, morphological, pomological and chemical properties were determined based on IPGRI and UPOV descriptors. Obtained findings are presented in tables.

5.2. Recommendations

As a result of this study, it was observed that these varieties are suitable to be grown in these regions and there is no problem in terms of fruit production. On the other hand, it was concluded that it would be appropriate to cultivate Malta and Abas Ali cultivars for the production of splitted fruit, that is, for table production and for green interior production. However, the selection of suitable male trees, which is one of the problems that may be encountered in the cultivation of these varieties, is very important. For this reason, it is necessary to determine the problems related to orchard maintenance, such as combating diseases and pests, especially male trees, irrigation, fertilization, etc. in cultivation. Particular attention should be paid to irrigation and fertilization for the solution of the periodicity problem. It is recommended to continue researches on pistachio in this region, especially to make new projects on rootstock and variety.

REFERENCES

- ACAR, I., and AK, B. E., 2001. An Investigation on Pollen Germination Rates of Some Selected Male Trees at Ceylanpınar State Farm, Cahiers Option Mediterranean's, Vol: 33. GREMPA Seminar, 63-66p.
- ACAR, I., 1997. Ceylanpınar Tarım İşletmesinde Seçilmiş Bazı Erkek Antepfıstığı Tiplerinin Morfolojik ve Biyolojik Özellikleri Üzerinde Bir Araştırma. Harran Üniversitesi, Fen Bilimleri Enstitüsü, Yüksek Lisans Tezi (Yayınlanmamış), Şanlıurfa, 159p.
- ACAR, I., 2012. Antepfıstığında Tozlanma ve Döllenme. Antepfıstığı Araştırma Dergisi, Gaziantep, Sayı: 1, 8-10p.
- AGAR, T, KASKA, N., and KAFKAS, S., 1995 Effect of different Ecologies on the fat content and fatty acid Composition of Different *Pistacia vera* Varieties grown in different parts of Turkey. Acta Hort, 419: 411-415.
- AK, B. E., 1992. Effects of Different *Pistacia* spp. Pollens on the Fruit Set and Quality of Pistachios. (In Turkish with an English summary) Cukurova University Institute of Natural and Applied Science. Department of Horticulture, PhD. Thesis, Adana, 210 p.
- AK, B. E., 2014. Antepfıstığı Genetik Kaynaklarının Korunması ve Islah Çalışmaları. TEMA Antepfıstığı Üretiminden Tüketimine Kadar Yaşanan Sorunlar ve Çözüm Yolları Paneli, 10 Ekim 2013, Şanlıurfa. Bildiriler Kitabı, 9-29p.
- AK, B. E., OZGUVEN, A. I., and NIKPAYMA, Y., 1995. An Investigation on Determining the Ability of Some *Pistacia* spp. Pollen Germination, Acta Hort, 419: 43-48.
- AMERICAN OIL CHEMISTS' SOCIETY. CHAMPAIGN., 1990. Official Methods and Recommended Practices. Vol. 1, 4th ed., II. USA.
- ARPACI, S., ATLI, H. S., TEKIN, H., and BURAK, M., 2005. Studies on Spring Frost Resistance of Some Pistachio (*Pistacia vera* L.) Cultivars. Tehran 4th International Symposium on Pistachio and almond, Iran Acta Horticulturae, 726: 391-395p.
- ARPACI, S., TEKIN, H., and ATLI, H. S., 1997. Türkiye'de Yabani *Pistacia* Türlerinin Yayılım Alanları. In-Situ Projesi Yıllık Gelişme Raporu, Antepfıstığı Araştırma Enstitüsü, Gaziantep.
- ASLAN, M., ORHAN, I., and SENNER, B., 2002. Comparison of the Seed Oils of *Pistacia vera* L. of Different Origins with Respect to Fatty Acid. Int. J. Food Sci. And Tech. 37.333–335.
- ATLI, H. S., ARPACI, S., AKGUN, A., and ACAR, I., 2003. Cultivar- Rootstock Combinations for Unirrigated Pistachio in Turkey. In XXVI International Horticultural Congress: Genetics and Breeding of Tree Fruits and Nuts 622 (pp. 567-571).
- ATLI, H. S., KASKA, N., and ETI, S., 1995. Selection of Male *Pistacia* spp. Types Grown in Gaziantep. First International Symposium on Pistachio Nut, Adana– Turkey 20-24 september 1994, Acta Horticulturae, 419: 319-322.
- AYDIN, C., and OZCAN, M. 2002. Some Physico-Mechanic Properties of Erebinth Fruits. Journal of Food Engineering, 53, 97–101.
- AYFER, M., 1964. Pistachio Nut Culture and Its Proplems With Special Refrence to Turkey. Reprinted from Univ of Ankara. Yearbok of the Faculty of Agriculture Ankara. p. 189-217

- AYFER, M., 1967. Antepfıstığında Megasporogenesis, Megagametogenesis, Embriyogenesis ve Bunlarla Meyve Dökümleri Arasındaki Münasebetler. T.C. Tarım Bakanlığı Teknik Kitap. D- 414. Dizerkonca Matbaası 54p.
- BALASUBRAMANIAN, D., 2001. Physical properties of raw cashew nut. *Journal of Agricultural Engineering Research*, 78(3), 291–297.
- BARYEH, E. A., and MANGOPE, B. K., 2002. Some Physical Properties of QP-38 Variety Pigeon Pea. *Journal of Food Engineering*, 56, 59–65.
- BILGEL, L., 2012. Antepfıstığında Sulamanın Verim ve Kaliteye Etkisi. *Antepfıstığı Araştırma Dergisi*. Sayı 1, S. 11-12. Gaziantep.
- BILGEN, A. M., 1968. Memleketimizde Bulunan Antepfıstığı Anaçları ve Aşılama Tekniği. Tarım Bakanlığı Ziraat İşleri Gn. Md. Teknik Neşriyat Şb, Yenigün Matbaası. Ankara.
- BILGEN, A. M., 1973. Antepfıstığı. Gıda Tarım ve Hayvancılık Bakanlığı, Basın Yayınevi Halkla İlişkiler Dairesi Başkanlığı Yayınları. Ankara S. 42-51.
- CARMAN, K., 1996. Some Physical Properties of Lentil Seeds. *Journal of Agricultural Engineering Research*, 63, 87–92.
- CHANDRASEKAR, V., and VISWANATHAN, R., 1999. Physical and thermal properties of coffee. *Journal of Agricultural Engineering Research*, 73, 227–234.
- CRANE, J. C., 1974. Hermaphroditism in Pistacia. *Calif Agric*. 28:3–4.
- CRANE, J. C., and IWAKIRI, T., 1988. Further Observations on Inflorescence Bud Drop and Consequent Alternate Bearing. *California Pistachio Industry Annual Report Crop Year (1987-1988)*.
- CRANE, J. C., and NELSON, M. M., 1971. The Unusual Mechanism of Alternate Bearing in the Pistachio. *Hort. Sci.* Vol. 65(5) 489-490.
- DAVARINEJAD, G.H., RASHED, M. H., and CSILAG F, 1995. The morphology of pollen grains as an indicator for identification of male pistachio trees. *Acta Hort*. 419:37-42.
- DEHSPANDE, S. D., BAL, S., and OJHA, T. P., 1993. Physical properties of soybean. *Journal of Agricultural Engineering Research*, 56, 89–98.
- ERDOGAN, V., 2014. Antepfıstığı Çeşitleri. Antepfıstığı Vitrine Çıkıyor Projesi. TRC1/13/DFD/ 3046. S. 105-117 Antepfıstığı.
- FERGUSON, L., POLITO, V., and KALLSEN, C., 2005. The pistachio tree; botany and physiology and factors that affect yield. *Pistachio production manual, 4th ed.* Davis, CA, USA, University of California Fruit & Nut Research Information Center, 31-39.
- FOGLE, H.W., 1977. Identification of Tree Fruit Species by Pollen Exine Patterns. *J. AMER. SOC. HORT. SCI.* 102 (5):548-551.
- GEZER, I., HACISEFEROGULLARI, H., and DEMIR, F., 2002. Some physical properties of hacihaliloglu apricot pit and kernel. *Journal of Food Engineering*, 56, 49–57.
- GHAFFARI, S. M., and HARANDI, O. F., 2001. Chromosome counts and assessment of two heterochromatic chromosomes in some species of Pistacia L. from Iran. III. Abstracts of International Symposium on Pistachios and Almond-XII GREMPA Colloquium, Zaragoza, Spain, 70.
- GUPTA, R. K., and DAS, S. K., 1997. Physical properties of sunflower seeds. *Journal of Agricultural Engineering Research*, 66, 1–8.

- HORMAZA, J. I., DOLLO, L., and POLITO, V. S., 1998. Genetic diversity of Pistachio (*Pistacia vera*, Anacardiaceae) germplasm based on randomly polymorphic DNA (RAPD) markers. *Economic Botany* 52:78–87.
- HSU, M. H., MANNAPPERUMA, J. D., and SINGH, R. P., 1991. Physical and thermal properties of pistachios. *Journal of Agricultural Engineering Research*, 49, 311–321.
- ILA, H. B., KAFKAS, S., and TOPAKTAZ, M., 2003. Chromosome number of four Pistacia (Anacardiaceae) species. *J. Hort. Sci. Biotech.* 78:35–38.
- IPGRI. International Plant Genetic Resources Institute. Erişim Tarihi: 04.06.2019.
- ISFENDIYAROGLU, M., and OZEKER, E., 2009. Inflorescence features of a new exceptional monoecious Pistacia atlantica Desf. (Anacardiaceae) population in the barbaros plain of İzmir/Turkey. *Intern. J. Plant Production* 3:93–97.
- JOLEY, L.E., 1973. (Çeviri:BilalYardımcı) .Sert Kabuklu Fıstık (Antepfıstığı) Tar. Bak. Zir. İşl. Gn. Md. yayınları D-154
- JOSHI, D. C., DAS, S. D., and MUHERJEE, R. K., 1993. Physical properties of pumpkin seeds. *Journal of Agricultural Engineering Research*, 54, 219–229.
- KAFKAS, S., and PERL-TREVES, R., 2001. Morphological and Molecular Phylogeny of Pistacia Species in Turkey. *Theor. Appl. Genet.* 102: 908–915.
- KAFKAS, S., PERL-TREVES, R., and KASKA, N., 2000. Unusual Pistacia atlantica Desf. (Anacardiaceae) Monoecious Sex Type in the Yunt Mountains of the Manisa Province of Turkey. *Israel. J Plant Sci* 48:277–280.
- KANBER, R., EYLEN, M., KOKSAL, H., and YUKSEL, G., 1990. Güneydoğu Anadolu Koşullarında Antepfıstığı (*Pistacia vera* L.) Verim ve Su Tüketiminin İrdelenmesi. *Türkiye 1. Antepfıstığı Sempozyumu*, Gaziantep. s: 145-158
- KANBER, R., KOKSAL, H., STEDUTO, R., TEKIN, H., and YUKCEKEN, Y., 2000. Damla Sulama Yöntemiyle, Fertigasyon Uygulamalarının Antepfıstığında Gelişme, Verim ve Periyodisiteye Etkisinin İncelenmesi, Çukurova Üniversitesi Ziraat Fakültesi Tarımsal Yapı ve Sulama Bölümü 3. Dönem Gelişme Raporu. Adana.
- KASHANINEJAD, M., MORTAZAVI, A., SAFEKORDI, A., and TABIL, L. G., 2006. Some Physical Properties of Pistachio (*Pistacia vera* L.) Nut and its Kernel. *Journal of Food Engineering*, 72(1), 30-38.
- KASKA, N., 1995. Pistachio Nut Production Growing in Turkey. *Acta Horticulturae*, 419: 161-164.
- KOKWARO, J. O., and GILLET, J. B., 1980. Notes on the Anacardiaceae of Eastern Africa. *Kew Bull.* 34, 745–760.
- KURU, C., 1993. Dikimden Hasada Antepfıstığı Yetiştiriciliği. Kahramanmaraş. 93 p.
- KURU, C., and AYFER, M., 1984. Antepfıstığı Çiçeklerinin Yapay Yöntemlerle Tozlanması Üzerine Araştırmalar. Doktora Tezi. Gaziantep Zir. Araş. Enst. Yayınları: 1, 24p.
- KURU, C., UYGUR, N., TEKIN, H., KARACA, R., and AKKOK, F., 1988. Antepfıstığı Yetiştiriciliği. Tar. Or. Bakanlığı Mesleki Yayınlar Serisi Genel:315, Seri 11. 54p.
- MAGGS, D. H., 1972. Pistachios in Iran and California. 1972. *Pl. Intro. Rev.* 9:12–16.
- MAGGS, D. H., 1973. Genetic resources in pistachio. *Plant Genetic Resources Newsletter.* 29:7–15.
- MAGGS, D. H., 1975. Prospect for Pistachio Nut Growing in Australia. *Csiro-Reprinted Form.* 47-63.

- MARANTO, J. and CRANE, J. C., 1982. Pistachio production. Division of Agr. Sciences. Univ. of California leaflet 2279, 18pp.
- MARTENS, J., and FRETZ, T. A., 1980. Identification of Eight Crab Apples by Pollen Source Sculpture. J. AMER. SOC. HORT. SCI. 105:257-263.
- MASKAN, M., and KARATAS, S., 1998. Fatty Acid Oxidation of Pistachio Nuts Stored Under Various Atmospheric Conditions and Different Temperatures. Journal of the Science of Food and Agriculture, 77(3), 334-340.
- MOHSENIN, N. N., 1980. Physical Properties of Plants and Animal Materials. New York: Gordon and Breach Science Publishers, NW.
- MOORE, P. D., and WEBB, J. A., 1978. An Illustrated guide to pollen analysis, Honduran Stoughton, London. P.P.131.
- NAKHAEINEJAD, M., 1998. Pistachio hulling and processing in Iran. Kerman, Iran: Momtazan Industrial Co.
- OGUT, H., 1998. Some physical properties of white lupin. Journal of Agricultural Engineering Research, 56, 273–277.
- OKAY, Y., 2014. Antepfıstığı'nın Döllenme Biyolojisi Antepfıstığı Vitrine Çıkıyor Projesi. TRC1/13/DFD/3046. S.75-94 Antepfıstığı.
- OLAJIDE, J. O., ADE- OMOWAYE, B. I. O., and OTUNOLA, E. T., 2000. Some physical properties of shea kernel. Journal of Agricultural Engineering Research, 76, 419–421.
- OLOSO, A. O., and CLARKE, B., 1993. Some aspect of strength properties of cashew nuts. Journal of Agricultural Engineering Research, 55, 27–43.
- OZBEK, S., and AYFER, M., 1957 .*Pistacia* Türleri Üzerinde Stolojik Araştırmalar. Ankara Üniversitesi Ziraat Fakültesi Yıllığı. Fasikül 3: 204-222
- OZBEK, S., 1978 .Özel Meyvecilik (Kışın Yaprağını Döken Meyve Türleri). Çukurova Üniversitesi Ziraat Fakültesi Yayınları: 128, 322-364. Adana.
- OZBEK, S., and AYFER, M., 1958. An hermaphrodite *Pistacia* found in the vicinity of Antep, Turkey. Proc. Amer. Soc. Hort. Sci. 72: 240–241.
- PARFITT, D. E., and BADENES, M. L., 1997. Phylogeny of the Genus *Pistacia* as determined from analysis of the chloroplast genome. Proc. Nat. Acad. Sci., USA 94:7987–7992.
- PARFITT, D. E., KAFKAS, S., BATLLE, I., VARGAS, F. J., and KALSEN, C. E., 2012. Pistachio. In Fruit Breeding (pp. 803-826). Springer, Boston, MA.
- RAZAVI, S., 2006. Pistachio production, Iran vs. the world. In IV International Symposium on Pistachios and Almonds 726 (pp. 689-694).
- SHEIBANI, A., 1995. Pistachio production in Iran. Acta Horticulturae, 419: 165-168.
- SHOKRAI, E. H., 1977. Chemical composition of the pistachio nuts (*Pistacia vera* L.) of Kerman, Iran. Journal of food science, 42(1), 244-245.
- TALIE, A. R., and IMANI, A., 1998. Morphology of pollen grains as an index for identification of local Iranian Almond varieties. Acta Hort.470:280-285.
- TEKIN, H., 2014. Antepfıstığı'nın Toprak İsteği ve Gübreleme. Antepfıstığı Vitrine Çıkıyor Projesi. TRC1/13/DFD/3046. S. 97-103 Antepfıstığı.
- TEKIN, H., and AKKOK, F., 1995. Selection of Pistachio Nut and Their Comparison to Turkish Standard Varieties. Acta Hort. (ISHS) 419: 287-292.
- TEKIN, H., AKKOK, F., KURU, C., and GENÇ, Ç., 1995. Determination of Nutrient Contents *Pistacia vera* L. and Assessment of the Most Suitable Leaf Collection Time. Acta Hort. (ISHS), 419:137-142.

- TEKIN, H., ARPACI, S., ATLI, H. S., ACAR, I., KARADAG, S., YUKCEKEN, Y., and YAMAN, A., 2001. Antepfıstığı Yetiştiriciliği. Antepfıstığı Araştırma Enstitüsü Müdürlüğü, Yayın No:13. 132 s. Gaziantep.
- TEKIN, H., GENÇ, Ç., KURU, C., and AKKOK, F., 1985. Antepfıstığı Besin Kapsamlarının Belirlenmesi Üzerine Araştırmalar. Bahçe Dergisi, 14(1-2).
- TEKIN, H., and GUZEL, N., 1992. Gaziantep Yöresinde Toprak ve Yaprakta Yapılan Farklı Gübre Uygulamalarının Antepfıstığının Yaprak Bileşimi, Gelişme, Verim ve Ürün Kalitesine Etkilerinin Araştırılması. Doktora Tezi Çukurova Üniversitesi. Fen Bilimleri Enstitüsü Kod. No: 182, Adana
- TEKIN, H., GUZEL, N., and IBRIKCI, H., 1995. Influence of Manure and Inorganic Fertilizer on Growth, Yield and Quality of Pistachio in South eastern Turkey. Acta Hort. (ISHS) 419:129-134.
- TEKIN, H., KUDEN, A. B., KASKA, N., and AK, B. E., 1995. Determining the Chilling Requirement and Growing Degree Hours of Some Pistachio Nut Cultivars and Regions. Acta Hort. (ISHS) 419: 85-90
- UPOV. The International Union for the Protection of New Varieties of Plants. Erişim Tarihi: 04.06.2019.
- WANNAN, B. S., and QUINN, C. J., 1991. Floral structure and evolution in the Anacardiaceae Bot. J. Linn. Soc. 107:349–385.
- WHITEHOUSE, W. E., 1957. The pistachio nut - A new crop for the Western United States. Economic Botany, 11:281–321.
- WHITEHOUSE, W. E., KOCH, E. J., JONES, L. E., LONG, S. C., and STONE, C. L., 1964. Influence of Pollens from Diverse *Pistacia* Species on Development of Pistachio Nuts Amer.Soc.HortSci. (84): 224-229.
- WOODROOF, J. G., 1979. Tree nuts: Production Processing Products (2nded.). Westport, Conn: AVI.
- YAKAR, Y., ARSLAN, H., and OZCINAR, A. B., 2021. Determination of fatty acid compositions of some sesame (*Sesamum indicum*, L.) genotype grown as second crop in Siirte ecological conditions. *GUSTIJ*. 11(1):27-33
- YALCIN, R., (2020). Bazı Antepfıstığı Genotiplerinin Fenolojik, Morfolojik ve Pomolojik Özellikleri, Mustafa Kemal Üniversitesi, Fen Bilimleri Enstitüsü, Yüksek Lisans Tezi, Hatay, 115 p.
- YI, T., WEN, J., GOLAN-GOLDHIRSH, A., and PARDFITT, D.E., 2008. Phylogenetics and Reticulate Evolution in *Pistacia* (Anacardiaceae). American J. of Botany. 95(2):241–251.
- ZOHARY, M., 1952. A Monographical Study of the Genus *Pistacia*. Palestine J Bot. 5:187–228.

