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Mediterranean Fruits

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The Mediterranean basin has long been a site of temperate fruit and nut production. Grapes, olives, figs, almonds, dates, and carobs have been cultivated there since early times. This area has both active consumption and commerce in these crops. Mediterranean countries are also rich sources of plant germplasm with the potential for new crops, and the revival of old crops. Recently interest in traditional diets, particularly in the Mediterranean diet, has increased among the public and scientific health communities. At a recent international symposium (Tree Nuts, Health and the Mediterranean Diet), in San Francisco, scientists presented several lines of evidence indicating the Mediterranean diet has the potential to prevent heart disease and other chronic diseases (Drescher et al. 1995).

Grains, legumes, fruits, vegetables, olive oil, wine, seeds, and tree nuts are a part of the "Traditional Healthy Mediterranean Diet Pyramid" (Fig. 1), a diet now associated with the good health and high adult life expectancy of the Mediterranean people (Sacks 1995). Traditional Mediterranean fruit and nut crops include grapes, olives, figs, almonds, hazelnuts, pistachios, pomegranates, apricots, and citrus. One important aspect is the fat in olive and nut oils is mostly unsaturated, good for the prevention of heart disease. These oils are very high in monounsaturated fat (oleic acid), and secondarily high in polyunsaturated fat (linoleic acid).

Olive oil, an important part of the Mediterranean diet, has been object of renewed interest in recent years. Other Mediterranean crops, such as mandarins, figs, loquats, persimmons, pomegranates, pistachios, carob pods, and cactus pear, have received little attention up until now but are now being re-emphasized in areas with Mediterranean climates for diversification and revitalization of local agriculture. These crops are important in many Mediterranean countries: Spain, Portugal through Southern France to Italy, Greece, Turkey, and the Middle East through Morocco and Tunisia to Egypt. They are also being introduced in other areas of the world such as California, Australia, and South America. The economic importance of these Mediterranean crops is shown in Table 1.

Mediterranean crops covered are a diverse group, ranging from those of major international importance supporting large industries to locally important species grown only in home-gardens. They vary in their contribution to local diets (Table 2). While the majority are high in carbohydrate and supply some vitamins and minerals, many are of low nutritional value. Some, such as carob and cactus pear, make a significant contribution to carbohydrate intake to local diets; these multi-purpose plants have a wide range of uses in medicine, industry or agriculture, agroforestry and soil conservation, and for production in marginal lands in semi-arid environments.

The current state of genetic erosion of these crops is quite high. This is a result of many factors, including the origin and distribution of the crop, its breeding system, the propagation methods used, commercial policies, and lack of research. In recent years several countries of Southern Europe have started surveys of native material of these crops in collections and gene pools (IBPGR 1986; Bettencourt and Konopka 1989; Lionakis 1994; Llacer et al. 1994; Monastra et al. 1994). Traditionally morphological and physiological characteristics have been used to identify these cultivars (Zielinski 1955). Some of them are strongly influenced by the environment, and their use as indicators of performance may lead to unreliable or erroneous results. For this reason isozyme gel electrophoresis is increasingly being used for cultivar identification in many tree crops (Arulsekar and Parfitt 1986; Ryugo et al. 1988; Tous et al. 1992).

MEDITERRANEAN FRUIT CROPS

The current situation of nine temperate Mediterranean fruits and nuts in the world, will be discussed in descending order of economic importance.

Olive

The cultivated olive (*Olea europaea* , Oleaceae) is a long-lived, evergreen tree native to the Mediterranean basin. It is valued for its fruit and oil. Mediterranean countries account for around 95% of the world's olive cultivation (8,702,000 ha). In the Mediterranean 90% of the olive trees are grown for the oil. World olive oil production is currently increasing; the commercial crop during 1990-1994 was 1,796,900 t (IOOC 1994), with the European Community (EC) producing around 1,337,000 t (Spain 40%, Italy 33%, and Greece 22%), Tunisia 194,000 t and Turkey 61,500 t of oil. World table olive production in 1990-1994 was 954,500 t (IOOC 1994). Spain is the world's largest producer (23%) and exporter of table olives, follow by Turkey (12%), U.S. (11.4%), Morocco (8.5 %), Syria (7.5%), and Greece (7.3%). In Australia, Chile, China, Mexico, New Zealand, and South Africa, olives are considered a new crop.

The olive oil and table olive industries play an important role in the agricultural and processing sectors of the major olive producing countries. Most olive oil is consumed within the Mediterranean countries; only 18% of production enters world trade. On average from 1988 through 1991 the world olive oil marketed represented 6% of the quantity and 23% of the value of the world trade in fluid edible oils (UNCTD 1993). To a large extent olive oil does not compete with other vegetable oils but occupies a specialty niche market.

The olive tree has a wide range of adaptability. It requires a mild climate with warm summers and cold winters. The tree requires substantial chilling for good fruiting (Martin et al. 1994), but is injured when temperatures fall below -10deg.C. Olive is considered a drought-resistant species because it thrives in areas where water stress is frequent: Mediterranean climates. It has been postulated that the minimum water requirement for olive is 2,000 m^3/ha year, mainly during flowering and fruit setting in late spring, and again in the summer as the fruit increases in size (Tous 1990; Bongi and Palliotti 1994). Olive trees will grow on poor soils and rocky hillsides, but deep soils produce the best quality fruit. They tolerate saline or alkaline soils and those with a high lime content. Their root system is relatively shallow, and will not tolerate waterlogged soils.

Olives are wind pollinated, thus flowering during rain, high temperatures and dry wind conditions are deleterious to good fruit set (Griggs et al. 1975). Mature olive trees produce huge numbers of flowers, but the fruit set is normally below 5% (Lavee 1986; Martin et al. 1994). Most olive cultivars will set some fruit in a monocultivar culture. However, they benefit greatly from cross-pollination (Lavee 1986). Olives are picked late in autumn or winter, as the oil content and fruit characteristics change with ripening. Olive cultivars usually fall into one of two commercial uses (Jacoboni and Fontanazza 1981; Barranco and Rallo 1984; Tous and Romero 1993): "Oil" and "Table." "Oil" cultivars predominate. The most famous are: 'Picual',

'Arbequina', 'Cornicabra', 'Hojiblanca', and 'Empeltre' in Spain; 'Frantoio', 'Moraiolo', 'Leccino', and 'Pendolino' in Italy; 'Koroneiki' in Greece; 'Chemlali' in Tunisia; 'Ayvalik' in Turkey; 'Mission' in California and Australia, etc. The "table olive" cultivars include 'Manzanilla' and 'Gordal' (syn. 'Sevillano' in California and 'Queen' in Australia) from Spain; 'Kalamata' from Greece; 'Ascolano' from Italy; 'Barouni' from Tunisia, etc. Alternate bearing is a problem with some cultivars.

Tree management of this crop has undergone many changes in recent decades including increased planting densities (100 to 300 trees/ha), new methods of propagation, improved cultural practices and mechanical harvesting, are some examples. Growth regulators, such as naphthaleneacetic acid (NAA), are used for fruit thinning to increase the fruit size and control the alternate bearing in some table olive orchards (Lavee 1986; Martin et al. 1994). Olives are propagated primarily by cuttings, truncheons or by budding seedling rootstocks. The trees propagated by rooting semi-hardwood cuttings come into bearing within three to four years after planting. The type of harvest depends upon fruit use. Oil olives are harvested by hand or by mechanically shaking the tree. Those for pickling must still be harvested by hand as the fruit bruises easily. The major pest problems are the following: olive fly (*Dacus oleae,* mainly in the Mediterranean basin), black scale (*Saissetia oleae*), olive leaf spot (*Spilocaea oleaginea*), olive knot (*Pseudomonas savastanoi*), and *Verticillium dahliae* .

Olives are nutritious (Table 2), the oil component includes unsaturated fatty acid (70% to 80% oleic acid and 7% to 12% linoleic acid), and small amounts of polyphenols, tocopherols, sterols, and many aromatic compounds (Mataix and Martinez 1988; Tous and Romero 1993).

Olive oil and table olive industries play an important role in the agricultural and processing sectors of the major olive producing countries of the Mediterranean basin. World olive oil production and exports are projected to increase slightly in the next few years, while table olive production will remain stable. While Italian olive oil production is expected to stabilize or decrease, Spain, Tunisia, Morocco, and other countries (Argentina, Australia) are expected to achieve substantial increases in this crop (UNCTD 1993). In addition to culinary uses, olive oil, an unsaturated fat, has recently become more valued for its health benefits. Mainly for this reason, through the last decade the olive oil consumption has increased in several non-Mediterranean countries (USA, Australia, Japan, etc.).

Mandarin

The mandarin (*Citrus reticulata* , Rutaceae) is the largest and most varied group of edible citrus. It is a native of China and Southeast Asia, and was known and extensively planted in China and Japan in the 16th century, but was not introduced to Europe and North America until the 19th century (Webber 1967; Saunt 1990). World production of mandarins is currently increasing; the commercial crop in 1993 was 9,570,000 t, 12.5% of the total world citrus production (FAO 1993). Spain and Japan each account for 16% of the world production. Other major producers in descending order of production are China (8%), Brazil (7%), Korea (6.5%), Italy (5%), United States (4.7%), and Morocco (4%). While production by Japan has decreased around 40% over the last decade, that of Mediterranean countries has increased by 50% (Saunt 1990; Ferguson 1992).

The mandarin has a wide range of adaptability and is grown under desert, semi-tropical and sub-tropical Mediterranean climatic conditions. Mandarin trees and their hybrids are usually the most cold-resistant of all commercially grown citrus. However, mandarin fruits suffer more frost damage than most oranges and grapefruit. The climate in which mandarins are grown has a great influence on fruit quality. Most commercial mandarins are irrigated, but excessively wet conditions should be avoided as this may lead to increased disease. Windbreaks are commonly planted to protect crops from high winds. Light, fertile loams are ideal, although a wide range of soils will produce good crops.

Mandarins are called "slip-skin" oranges "zipper skin" or "easypeeler" because they have loose skins and are easy to peel and separate into segments. The fruit has long been appreciated for its distinctive and sweet flavor and aroma. They are used primarily for eating out-of-hand, as fruit sections, in fresh juice, and to a limited extend for processing (Young 1986). Mandarin cultivars usually fall into one of three commercial groups (Bono et al. 1985; Saunt 1990): "Satsumas" ('Owari', 'Okitsu', and 'Clausellina');

"Clementine" ('Arrufatina', 'Clemenules', 'Esbal', 'Fina', 'Hernandina', 'Marisol', and 'Oroval'); and "other mandarins and hybrids" ('Dancy', 'Fairchild', 'Fortune', 'Kara', 'Nova', and 'Wilking'). Careful selection of three or four mandarin cultivars per orchard can yield fresh fruit for an eighth-month ripening period, beginning in mid-Sept. with 'Okitsu' and 'Clausellina' and extending into Apr.-May with late cultivars such as 'Fortune'. Some cultivars such as 'Comun mandarin', 'Dancy', 'Fairchild', 'Fortune', require cross-pollination for best fruit production (Eti and Stosser 1992).

This evergreen tree requires close plantings (2 x 5 m) and minimum heights for easier harvesting; in this dense planting system it is customary to hedge prune mechanically. Growth regulators are used to control alternate bearing and substitute for pollination, which produces excessive seeds. Mandarins are propagated by budding selected scions on to nucellar seedling rootstocks; a commonly used rootstock is 'Cleopatra' mandarin (Samson 1980). However, any of the rootstocks noted for producing high quality fruit are suitable. The tree comes into bearing three to four years after planting. Most of the pests that attack citrus may be present in mandarin orchards. The major pests are aphids, scale insects, whiteflies, citrus thrips, fruit flies and mites.

Overall, world mandarin production and exports are projected to lightly increase in the next few years. While Japanese production is expected to stabilize or decrease, Spain, Morocco, and other Mediterranean countries are expected to achieve substantial increases in this crop. The excellent quality and characteristic flavor of the new mandarin cultivars are highly prized by some, and if seedless varieties of larger size can be obtained, their popularity will greatly increase.

Fig

The fig (*Ficus carica* , Moraceae) probably originated in Western Asia, and spread to the Mediterranean. Today, the fig is a moderately important world crop, with an estimated annual production of one million tons of fruit (Sadhu 1990). Approximately 40% of this crop is sold as dried fruit. About 30% of the crop is produced by Turkey (300,000 t). Other major producers in descending order are Egypt (160,000 t), Morocco (57,000 mt), Spain (50,000 t), Greece (50,000 mt), California (43,000 t), Italy (40,000 t), Algeria (38,400 t), Syria (37,000 t), Tunisia (35,000 t), and Libya, Iraq, and Portugal (Sadhu 1990; CIHEAM 1994). While production by Italy and Spain has decreased over the last decade, that of Turkey, Syria, and Brazil has increased (IBPGR 1986).

The fruit usually is consumed fresh locally or in dried, canned, and preserved form. Dried figs and those unfit for human consumption, can be used as animal fodder. Several countries import dried figs or the paste. The main exporters of dried figs and paste are Turkey and the United States. Of California's production, 85% is marketed as dried figs, 12% as canned figs and fig juice, and 3% as fresh fruit (Storey 1975). The nutritional value of fresh figs is comparable to that of many other fruits. They are high in calcium. Dried figs, with only 20% water are nutritious relative to other fresh fruits (Table 2).

The typical fig-producing regions have mild winters and hot dry summers. The fig tree is tolerant of a wide range of environmental conditions, has a low chilling requirement, will withstand some frost and is tolerant of drought, although it grows most vigorously with abundant water. A frost of -5° to -10°C may kill the plant down to ground level. Figs can be grown on a wide range of soils, including heavy clays, loams, and light sands, but ideally the soil should be well-drained. The plant is moderately tolerant of high salinity (IBPGR 1986).

There are two main commercial types of figs, the "common fig" that produces fruit without pollination, and the "Smyrna fig" that requires pollination by a fig wasp (*Blastophaga* spp.), that lives in the "caprifig" (male fig), to set fruit. The "common-type" (self-pollinated) fig is more commonly grown. These cultivars bear one or two crops per year. The most famous are: 'White Adriatic' (syn. 'Verdone'), 'Black Mission', 'Kadota' (syn. 'Dottato' in Italy), and 'Conadria' in California (Storey 1975; Ferguson et al. 1990); 'Cuello de Dama Blanco' and 'Napolitana Negra' in Spain (Llacer et al. 1994); 'Kalamon' in Greece (Lionakis 1994); 'Sultani' in Egypt and Tunisia (Mansour 1994; Mars 1994); 'Rhouddane' in Morocco (Loudyi 1994), etc. The "Smyrna-types" include the popular Turkish cultivar known as 'Sarilop' in Turkey and 'Calimyrna' in the United States and other cultivars of Algeria 'Taranimt' and 'Tameriout', that have high dried fruit quality (Rebour 1955; Aksoy 1994).

The tree is propagated by rooting 20 cm cuttings of one to three year old wood taken during the dormant

season. Trees are normally planted 4 m apart with 5-6 m between rows. Fruiting begins after three years. Regular fertilization will increase yields without reducing fruit quality. Figs carry two crops in a year, the main crop normally being the second crop in late summer and autumn. The first, or "breba" crop, is produced from flowers initiated in the preceding late summer and maturing from May to June. The second crop is produced from flowers on the current season's growth. Pruning may be required to maintain a balance between new and old wood, as well as to remove suckers and to keep the tree's canopy to a reasonable size for easy harvesting.

Fresh figs are picked when they begin to soften and the color change indicates maturity. When picking, gloves should be worn to prevent damaging the fresh fruit and to prevent the skin irritation caused by the white sap that contains ficin exuding from the broken stem. Since fresh figs ripen irregularly, picking should be done daily or weekly during the long harvest period (4-6 weeks). In California most figs are grown for drying. They are mechanically harvested by sweepers from the ground during Sept. and Oct. (Obenauf et al. 1978). After harvest, the dried figs are washed and can be stored for a few days at 0deg. to 1deg.C. Fruit is dried in the sun or by using an electric dryer at a temperature of 60deg. to 70deg.C before processing as dried figs.

Figs are not usually seriously affected by pests except in high rainfall areas. In these areas and during the rainy season, fruit cracking usually occurs and fungicide sprays may be necessary to control surface rot (*Alternaria alternata*), smut (*Aspergillus niger*), and mold of fig (*Botrytis* spp., *Penicillium* spp.). Aphids, birds, fruit flies, and scale insects are occasionally a problem. Figs are highly susceptible to nematodes and should not be planted in infested soils.

The economic importance of fig production is likely to continue into the future. In the world market, there is an increasing demand for fresh figs and a stable demand for dried figs. The most important trade aspects of this species are the short commercial life of the fresh fruits, and for the dried fruits, the market competition of Turkish production, where production costs are lower than for other countries (Europe). Fig production in some European countries is slowly decreasing. Turkey and Mexico are expanding their fig production. At present, evaluation of fresh cultivars in Europe and 'Calimyrna' improvement in the United States, combined with improved cultural practices and better fresh fruit postharvest practices are opening new prospects for this crop.

Persimmon

The persimmon (*Diospyros kaki* , Ebenaceae) is native to East Asia, most likely China. It has been cultivated in the Mediterranean basin for more than a century (Morton 1987). Europeans refer to the persimmon by the Japanese name *kaki* . World production is about 1,200,000 t annually from an area of approximately 235,000 ha, with China producing around 57% and Japan 27% of the crop. Smaller, but expanding persimmon industries are being developed in Italy (70,000 t), Korea (50,000 t), Brazil (45,000 t), Israel (10,000 t), Spain (8,000 t), the U.S. (7,000 t), New Zealand, and Australia (George and Nissen 1990; CIHEAM 1994; Mowat and George 1994). Persimmons are a deciduous, monoecious plant, and set fruit parthenocarpically or with pollination. They grow well in warm-temperate and subtropical areas, and tolerate the hot and humid coastal areas. They can tolerate winter temperatures of -12deg.C but require no winter chilling. Persimmons are grown on a wide range of soils but produce best on deep, fertile, medium-textured soil with good drainage. They produce better than most fruit trees on heavy clay soils. Ferguson and Arpaia (1990) showed that, under California San Joaquin Valley conditions (145-367 mm), they require at least 9,000-12,000 m^3/ha per year of irrigation in addition to annual rainfall.

The fruit is oblong-conical and shows wide variation in size, shape and color. Fruit may be yellow, orange, or red when ripe. Fruit is normally harvested from late Sept. to early Dec. for the fresh market or for drying. The fruit is sweet but most cultivars have an astringent taste until fully ripe. The cultivars are broadly classified for horticultural purposes into two major groups (Itoo 1980; Kitagawa and Glucina 1984; Morton 1987): "astringent" and "non-astringent," based on their flavor at maturity. The most important cultivars are 'Hiratanenashi', 'Hachiya', 'Tanenashi', 'Triumph', 'Kaki Tipo', and 'Rojo Brillante' (astringent); 'Fuyu', 'Jiro', 'Hana-Fuyu', and 'Gosho' (non-astringent). Until recently, most cultivars were commercial the astringent type. These can be treated with ethylene, CO2 and other chemicals to remove the astringency while the fruit is

still firm (Itoo 1980; LaRue et al. 1982).

The trees are trained to a modified central leader and require 7-10 years to reach full bearing. Propagation is by budding or grafting onto seedling rootstocks. Persimmons are relatively free of pests and diseases. The production problems depend on the growing areas. In Mediterranean countries the most pressing pest is the fruit fly (*Ceratitis capitata*), while in others (Japan, California, etc.) fungi such as anthracnose (*Gloesporium kaki*) and grey mold (*Botrytis cinerea*) are common diseases. Physiological problems include cracks radiating from the calyx, sunburn, post-flowering fruit drop, and alternate bearing.

The kaki or Japanese persimmon is mainly eaten fresh, but can be frozen, canned or dried, and is sometimes used in oriental cooking. They can be stored for up to 6 months in modified or controlled atmospheres. Persimmons are high in vitamin A, and are a moderate source of ascorbic acid (Table 2). Some astringent cultivars contain an average of 1.4% soluble tannins in skin cells when not fully ripe.

The persimmon has long been appreciated in the Far East as China and Japan together produce 80% of the world crop. The overall production trend is stationary. While Japanese production is expected to decrease, Brazil, Israel, Spain, Australia, and New Zealand are expected to increase plantings of this crop. The future of this fruit depends on the selection of high quality cultivars and specific marketing techniques to ensure a firm non-astringent persimmon reaching the consumer (George and Nissen 1990).

Pomegranate

The pomegranate (*Punica granatum* , Punicaceae), native to Persia, is one of the oldest known edible fruits. The total world crop was estimated at 800,000 t of fruit (IBPGR 1986). The tree has been cultivated extensively in the Mediterranean countries (Tunisia, Turkey, Egypt, Spain, and Morocco), Iran, Afghanistan, India, and to some extent in the United States (California), China, Japan, and Russia. The fruits normally are sold in the local markets of these countries, except Spain and Turkey which also export. The crop requires a long hot summer to mature the fruit, yet can withstand low temperatures of -9° to -12°C in the winter and is extremely drought-tolerant. Pomegranates grow naturally as a bushy shrub or a small tree with spiny branches, in subtropical areas with arid summers. The pomegranate bears heavily and regularly every year, and requires very little care. The tree adapts to a wide variety of soils.

The fruit is a false berry, subglobose in shape, shiny red, yellowish green or whitish, crowned with a persistent calyx, and has a hard rind. Internally, the fruit has few to many locules containing many seeds. The testa of the seed is filled with a whitish pulp (aril) and an acid juice. The seeds may vary in size and hardness. Fruits with hard seeds possess poor eating quality and, therefore, cultivars producing soft seeded fruits are preferred. Hard seeded fruits, having higher juice content and an intense red color are utilized for processing (Kumar 1990). Several cultivars are grown commercially in the world: 'Wonderful' in California and Israel; 'Mollar' and 'Tendral' in Spain; 'Schahvar' and 'Robab' in Iran; 'Hicaz' in Turkey; 'Zehri' and 'Gabsi' in Tunisia; 'Alandi' and 'Ganesh' in India, etc. (LaRue 1980; Morton 1987; Patil and Karale 1990; Aksoy 1994; Llacer et al. 1994; Mars 1994). The pomegranate is both self-pollinated and cross-pollinated by insects. The fruit is consumed fresh or can be processed into juice, a syrup (grenadine), jams, or a type of wine. The juice content of pomegranate fruit accounts for about 45% to 65% of the whole fruit or 76% to 85% of the arils. Table 2 lists general compositional data of pomegranate pulp. Pomegranates are also valued for their therapeutic properties (Kumar 1990).

The tree requires minimal pruning, except for removing suckers at the base of the plant and giving some shape to the canopy. It is propagated mainly by hardwood or softwood cuttings. The tree comes into bearing three to four years after planting. The fruit is harvested by hand from mid-Sept. to early Nov. The most important problems cause cracking of fruits that affects the pomegranate quality in storage. In India and Egypt the fruit borer (*Virachola isocrates*) is a serious pest (IBPGR 1986; Patil and Karale 1990). Different postharvest diseases such as *Aspergillus niger* , *Botrytis cinerea,* and *Alternaria* sp. cause the fruit to split before ripening. The practice of picking early in the season to avoid fruit cracking is known to result in poor quality fruit (Kumar 1990).

The pomegranate is resistant to the oak root fungus, *Armillaria mellea.*

Crop production is stable. Turkey and India may increase the area planted to pomegranate. The future of this fruit depends on the selection of high quality cultivars with soft seeds, higher total soluble solids and richer color (Kumar 1990) and fruits resistant to cracking and fruit borers.

Pistachio

The pistachio, (*Pistacia vera* , Anacardiaceae), probably originated in Central Asia, though it has often been referred in early histories of Western Asia, Asia Minor, and the Mediterranean countries. The fruits are classified as drupes with edible seeds. World production of pistachios is currently increasing, and the commercial crop in 1993/94 was about 258,000 t in-shell (INC 1995). The main producers are Iran (43%), the United States (26.5%, Sacramento and San Joaquin Valleys in California), Turkey (19.5%), Syria (8.5%), Greece (1.5%), and Italy (1%). Lesser quantities are produced in Lebanon, Tunisia, and Australia. Spain is a big importer of pistachio nuts, almost 10,000 t in-shell (Vargas 1990). There are good market possibilities for expansion of the pistachio crop in Turkey, Spain, and California (Chang 1990; Galan-Sauco and Rallo 1993).

The native range of pistachio is characterized by long, hot, dry summers and moderately cool or cold winters. In California the tree is grown in areas where winter temperatures accumulate 1,000 h under 7°C, the conditions required to break the rest period for normal growth and fruiting of 'Kerman' pistachio (Crane and Maranto 1988). Although pistachios will grow in rocky shallow soils, productivity is enhanced in a deep well-drained soils and by proper cultural practices. They tolerate saline or alkaline soils and those with a high lime content. Though originally from a xerophytic environment, they require more water than most fruit trees to produce well, approximately 10,000 m^3/ha per year under California Central Valley conditions (Ferguson and Arpaia 1990). In other areas of the Mediterranean basin, such as Southern Italy, the recommended minimal irrigation of 500-600 m^3/ha/year in the summer maintains good tree performance (Caruso 1990).

The pistachio is a moderately sized deciduous and dioecious tree (3 to 8 m). In commercial orchards the ratio of staminate trees to pistillate trees is 1 to 8. Pistachios have an extended juvenile period and require 5 years of training to establish a modified central leader canopy and 7 to 10 years to reach full bearing under good irrigated conditions. It is also a strongly biennial-bearing species, as fruit embryo growth induces the abscission of already induced floral buds (Crane and Iwakiri 1981). For example in Turkey the ratio of "on" to "off" trees is 1:1 (Kaska 1994). Cultivars differ among countries and are budded on seedlings of different *Pistacia* rootstocks. California's industry consists of one pistillate cultivar, 'Kerman', one staminate cultivar ('Peters') and four rootstocks (*P. terebinthus, P. atlantica, P. integerrima,* and the hybrid *P. atlantica* x *P. integerrima*). 'Kerman' was imported from Iran (then Persia) and named here for its province of origin and Peters for the Fresno grower who selected it. Other cultivars growing in others countries are 'Momtaz', 'Owhadi', and 'Kalehghouchi' in Iran; 'Uzun' and 'Kirmizi' and Turkey; 'Red Aleppo' in Syria; 'Aegina' in Greece; 'Bianca' in Italy; 'Mateur' in Tunisia; 'Larnaka' in Cyprus; and 'Sirora' in Australia; (Vargas 1985; Crane and Maranto 1988; Vargas et al. 1994).

The nuts are borne in clusters that can be harvested by hand, by knocking with a pole or by shaking. The crop matures in early autumn. Mechanical harvesting and processing procedures have been well developed in California. Aflatoxin contamination by the fungus *Aspergillus* is generally not a problem in California, as all pistachios are processed within 24 h of harvest (Ferguson and Arpaia 1990). No serious diseases of pistachio have been reported in Turkey or Iran. In California, however, many orchards have been seriously threatened by Verticillium wilt (*Verticillium dahliae*). Recent orchard surveys in California have revealed other diseases, such as Botrytis blossom and shoot blight (*Botrytis cinerea*), and Botryosphaeria panicle and shoot blight caused by *Botryosphaeria dothidea* are increasing in California (Michailides et al. 1988).

Pistachio nuts may be bought roasted and salted, shelled or unshelled, and are used in ice creams, sweets, cakes, and meat dishes. The kernels are nutritious (Table 2), with a fat component including 69% oleic acid and 19.8% linoleic acid (Woodroof 1979). Pistachio nut oils are also used in the cosmetic and pharmaceuticals industries (Caruso 1990).

World production of pistachios is currently increasing. The United States (California), Iran and several countries of the Mediterranean basin (Turkey, Greece) are expected to increase their planted hectares. The most serious problems of this tree are alternate-bearing, the soil borne fungus *Verticillium dahliae* , and the long juvenility.

Carob

The carob (*Ceratonia siliqua* , Fagaceae) is a perennial leguminous tree native to the Mediterranean basin and southwestern Asia (Smith 1976). Its cultivation began before written history. This species is also known as "St. John's Bread," "algarrobo" in Spain, "carrubo" in Italy, and "caroubier" in France. The beans and kernels are useful for a variety of purposes including food, fodder, and as a source of industrial products such as gums, sugar, and alcohol. The tree is also used for shade and erosion control (NAS 1979). World production of carob pods was estimated about at 330,000 t (Tous and Batlle 1990), mainly in Spain (45%), Italy (16%), Portugal (9%), Morocco (7.5%), Cyprus (6%), Greece (5%), and Turkey (4.5%). Lesser quantities are produced in Algeria, Tunisia, and Israel. Spain is also the world's largest exporter of carob beans. The only significant recent plantings outside the Mediterranean region are in Australia (Esbenshade and Wilson 1986; Tous 1995).

The tree grows best in a Mediterranean-type climate with cool, not cold, winters, mild to warm springs, and warm to hot summers with little rain. A frost of -4°C or below may kill the young trees, or shoots and flowers in mature trees. Although drought-resistant, carob trees do not bear commercial crops unless they get enough rainfall, a minimum average rainfall of about 500-550 mm is needed to ensure a profitable crop (NAS 1979). The tree survives in a wide variety of soils, like pistachio, but must have good drainage. Although it is a legume, it is unable to fix nitrogen (Martins-Loucao 1985).

The carob is a large (7 to 10 m) trioecious tree with staminate, pistillate and hermaphrodite inflorescences in different trees. Pollination is by insects (bees, flies, etc.) and the wind (Tous and Batlle 1990). In new commercial orchards the ratio of staminate or hermaphrodite trees to pistillate trees should be 1:8. In traditional orchards male branches are grafted on female trees to provide pollen in situ. The carob, like the pistachio, matures slowly and most budded cultivars begin to bear in the 5-6th year after planting. It is also a strongly alternate-bearing species, particularly when growing conditions are poor. Today, commercial cultivars differ in pulp quantity or yield of seeds. The most important cultivars are: 'Negra', 'Rojal', 'Matalafera', and 'Duraio' in Spain; 'Gibiliana' and 'Amele' in Italy; 'Mulata' and 'Galhosa' in Portugal; 'Tylliria' in Cyprus; 'Hemere' in Greece; 'Sfax' in Tunisia; and 'Santa Fe' in California (Tous and Batlle 1990).

The tree requires little pruning, and minimal cultural care. Carobs respond to N fertilization by increasing pod yield (Lloveras and Tous 1992). They are propagated mainly by budding or grafting onto seedling rootstocks. The flowers, which are borne in small lateral racemes or clusters, bloom during Sept.-Nov. on older wood. The carob bean is a dark-brown, fleshy edible pod, 10-30 cm long, containing 5-15 hard seeds, and ripening in late summer, during bloom. Carob seeds comprise about 10% to 20% of the weight of the pod. Fruits can be harvested by hand, by knocking down with a long pole, or by shaking. No serious problems of carob have been reported in the Mediterranean area. The major pests are the stem borer (*Zeuzera pyrina*) and carob moth (*Myelois ceratoniae*), and only one fungus, *Oidium ceratoniae* , is occasionally a problem in the leaves and young pods.

The carob pod is very rich in sugar (up to 45%) and low in protein. Mixed with other feeds higher in protein, it is good source of stock feed (horses, calves, goats, milk cow). Finely-ground pods make a sweet nutritious human food (Table 2), and are used in a similar manner to cocoa in cakes, drinks, puddings, breakfast cereals, and candy. The carob powder has more vitamins, minerals, and fewer fats, carbohydrates, and calories than chocolate made with cocoa. Additionally carob powder contains no caffeine and theobromine (Whitheside 1981). The carob gum or locust bean gum (LBG) surrounding the endosperm is an

important commercial stabilizer and thickener in many food industries (bakery goods, ice creams, baby foods, sauces, jams, cheese, jellies, and canned meats), as well as in pet foods, cosmetics, and pharmaceuticals (NAS 1979; Morton 1987; Di Lorenzo 1990; Tous and Batlle 1990).

The overall production trend is stationary. Several countries, such as Spain, Portugal, and Australia, are expected to have new plantings of this crop. In the world market, there is an increasing demand for carob seed and a stable demand for carob pulp. In the last 5 to 10 years, because of the rising prices of the carob seed derivatives (LBG), the carob has been the object of renewed interest (Tous and Batlle 1990).

Cactus Pear

The cactus pear (*Opuntia ficus-indica* ; *Opuntia* spp., Cactaceae) is a fleshy bush or small tree, native to the desert zones of Northwestern Mexico and the Southwestern United States (Knight 1980). The plant was brought to Europe by the first Spanish colonists from Mexico and has been cultivated along the Mediterranean coast since the late 17th century (Retamal et al. 1987). This fruit is also known as "barbary fig," "tuna," and "Indian fig." The total world crop was estimated at 300,000 t of fruit. Mexico's estimated current production of 200,000 t of fruit on an area of 50,000 ha (Flores and Gallegos 1994). The other important production region is the Mediterranean basin (Italy, Spain, Egypt, Morocco, and Israel) and to a more limited extent South America, South Africa, Southwestern Asia, the U.S., and Australia. The fruits normally are sold in the local markets of these countries, except for Mexico, Italy, and Chile which are also exporters. The cactus pear is not cultivated as a regular commercial crop, but rather is planted as fences, windbreaks, and gardens. The only significant plantings are in Mexico, Italy, Spain, Chile, Israel, and South Africa. The plant may reach a height of 5 m and prefers calcareous soils and semi-arid climate with temperatures ranging from 18° to 26°C.

The *Opuntia* is a cactus in which the branches or stems ("cladodes" or "nopalitos") have the appearance and function of a leaf. The fruit is generally pear-shaped and has a number of small spines, with a soft juicy pulp that contains numerous small black seeds. Fruits ripen and are harvested by hand from July to Dec.

The plant requires minimal cultural care. It is propagated mainly by vegetative means (cladodes or shoots). Fruiting begins at 2 or 3 years and reaches full production around 7 or 8 years. A mature plant can yield 100 to 200 fruits (Knight 1980). Many local cultivars have been developed, and generally are named for their fruit color at maturity, particularly in Mexico ('Reyna', 'Rojo Pelona', 'Esmeralda', etc.), Italy ('Gialla', 'Rossa', and 'Bianca') and Spain ('Verdales', 'Morados', 'Sanguinos', and 'Blancos') (Barbera et al. 1992; Flores and Gallegos 1994; Llacer et al. 1994). Future demand for this fruit depends upon developing high quality cultivars without spines and few seeds. Due to its xerophitic habitat the cactus pear does not have serious problems with pests and diseases. However in some areas the fruit fly (*Ceratitis capitata*) causes damage to the fruits, particularly during years with mild weather during autumn (Barbera et al. 1992; Lionakis 1994).

The vegetable stems ('nopalitos') and fruits of cactus pear are useful for a variety of purposes including food (fresh fruit, paste, jam, salads, and refreshing drinks), fodder (auxiliary feed for cattle, sheep, and goats), medicinal (antidiabetic agent) and for industrial products such as alcohol, soap, pigments, pectins, and oils (Lakshminarayana 1980; Borrego et al. 1990; Hegwood 1990). Table 2 lists general compositional data of cactus pear fruit pulp.

The present trend of the production of this fruit is increasing. In the future, Mexico, Italy, and South Africa are expected to increase the production of this fruit. Millions of hectares of marginal land in arid parts of the world, where irrigation cannot be supplied, can come into their own as food producers when improved cultivars of cactus pear are available (Knight 1980).

Loquat

The loquat (*Eriobotrya japonica* , Rosaceae) is a small, evergreen tree native to central-eastern China, introduced into Japan in very early times. In Europe it was planted in the 18th century (Morton 1987). It is grown both as an ornamental and for its fruit. The total world

crop was estimated as 150,000 t. It has been cultivated extensively in the Mediterranean basin (Spain, Algeria, Turkey, Israel, and Italy), Japan and China, to some extent in India and Brazil, and in a more limited fashion in Chile and the United States. Spain is the world's largest producer (40,000 t) and exporter of loquats, follow by Algeria (22,000 t), Japan (18,000 t), China, and Brazil (Lupescu et al. 1980; Morton 1987; Llacer et al. 1994). The tree grows best in a subtropical to warm-temperate climate. It does well on a variety of soils but does best on clay loams with good drainage.

The fruits, which are borne in large loose clusters, are commonly round, oval, or pyriform and in the best cultivars may reach a length of 7 cm. They vary in color from pale yellow to deep orange and have a tough plumlike skin. The flesh is white to orange, firm or soft, juicy, and flavorful. From 1 to 4 smooth, brown seeds are commonly found in each fruit. The seeds comprise about 20% to 30% of the weight of the whole fruit (Insero et al. 1990). Loquats are consumed largely as fresh fruit, although small amounts are used in jams, jellies, syrups, and pies (Shaw 1980). Loquats are high in vitamin A and minerals (Table 2). For the fresh market they should not be picked before full maturity; otherwise they are too acid. If properly handled they can be shipped to distant markets.

Generally, the loquat tree blooms in the autumn with fruits ripening in early spring (Apr.-May). They are normally pollinated by bees, but some cultivars such as 'Akko 13' from Israel and 'Golden Yellow' from India are not self-fertile, and others such as 'Advance' and 'Tanaka' are partially self-fertile. It has been observed that cross-pollination generally results in 10% to 17% increased production over self-pollination (Morton 1987). A list of important cultivars are: 'Advance', 'Algerie', 'Akko 13', 'Champagne', 'Magdall', 'Premier', 'Saint Michel', 'Tanaka', 'Thales' (syn. 'Gold Nugget'), etc. (Knight 1980; Morton 1987; Pathak and Gautam 1990).

The tree requires a minimal pruning, but some thinning of fruits may be required for optimum size. It is propagated mainly by budding or grafting onto seedling rootstocks; quince root can be used if a dwarf tree is desired. The tree comes into bearing in three to four years and the yield in the new orchards is very high (25 t/ha, Blumenfeld 1994). They are hand-harvested by clipping bunches of fruit and are sorted and graded by hand. The most important problems cause damage to the fruit rind, which downgrades fruit quality. In Europe two disorders damage the fruit rinds (Caballero 1993): sunburn ('purple spot'), a physiological disorder directly related to the calcium content in the fruit tissues, and the fungal black spot (*Fusicladium eriobotryae*). In California two diseases that sometimes create problems are fireblight (*Erwinia amylovora*) and loquat scab (*Spilocea pyracanthae*) (Ogawa and English 1991).

The overall production is steadily increasing. Several countries, such as Spain, Brazil, and India, are expected to increase commercial plantings of this crop. An interesting commercial aspect of loquat is that it ripens in early spring before other fruits (cherries, apricots, peaches, and plums) appear in the market. The most important problems (physiological and disease) result in a damaged fruit rind, which downgrades the fruit quality. Also, there is a need to reduce the labor costs of hand thinning and manual harvesting.

FUTURE PROSPECTS

In recent years, perhaps because of the crises that many agricultural sectors have experienced, and because of the need for new crop alternatives, and also for health reasons, interest has developed in traditional Mediterranean fruits. At present, olives, mandarins, figs, persimmons, and pistachios are receiving more research interest than other Mediterranean crops because these crops are sufficiently extensive and profitable enough to support university based research. As long as these crops continue to be profitable money for research support and market development will be available. However, the minor crops such as pomegranates, cactus pear, carob, and loquat do not have organized industries to support their research and market development. It now falls to nascent industry organizations, rare fruit grower associations, national agricultural services and individuals to develop these crops until they become more popular. Information about these less popular "new" crops is available online through such World Wide Web (WWW) home pages as the University of California Fruit and Nut Crop Research and Information Center and NewCROP (New Crop Resource Online Program) developed by Purdue University in Indiana.

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Table 1. Production, trend and leading countries of some Mediterranean fruit crops in the world. Sources: Knight (1980), IBPGR (1986), Sadhu (1990), George and Nissen (1990), Tous and Batlle (1990), IOOC (1994), and INC (1995).

Fruit crops	Commercial production (1,000 tonnes)	Trend	Leading countries
Olives	9,940[z]	Increasing	Spain, Italy, Greece, Tunisia
Mandarins	9,570	Increasing	Spain, Japan, China, Brazil
Figs	1,050	Stable	Turkey, Egypt, Morocco, Spain
Persimmons	1,200	Stable	China, Japan, Italy, Korea
Pomegranates	800	Stable	Tunisia, Turkey, Iran, Egypt
Pistachios in shell	258	Increasing	Iran, U.S., Turkey, Syria
Carobs	330	Stable	Spain, Italy, Portugal, Morocco
Cactus pear	300	Increasing	Mexico, Italy, Spain, Egypt
Loquats	150	Stable-increasing	Spain, Algeria, Japan, China

[z]90% of total olive production for olive oil.

Table 2. Nutritional composition of Mediterranean crops (per 100 g of edible portion). Source: Goulart (1980); Sawaya et al. (1983); Fernandez Diez (1983); IBPGR (1986); Morton (1987); Cantwell (1994).

					Carbohydrates			Minerals					Vitamins				
Crop/Product	Water (%)	Cal.	Protein (g)	Fat (g)	Total (g)	Fiber (g)	Ash (g)	Ca (mg)	P (mg)	Fe (mg)	Na (mg)	K (mg)	A (IU)	Thiamine (mg)	Riboflavin (mg)	Niacin (mg)	Ascorbic acid (mg)
Olive (ripe pulp)	70.8	163	1.2	18.6	--	1.7	2.1	79	19	0.9	760	48	200	0.01	0.18	0.1	3

Mandarin	87.0	45	0.8	0.1	13.0	0.5	0.3	30	23	0.4	5	140	30	0.08	0.03	0.2	45
Fig, fresh	78.0	80	1.3	0.3	20.3	2.0	0.6	50	22	0.6	2	194	80	0.06	0.05	0.4	2
Fig, dried	23.0	274	4.3	1.3	69.0	5.6	2.3	126	77	3.0	34	640	100	0.10	0.10	0.7	0
Persimmon	79.0	77	0.7	0.4	19.6	1.2	--	6	26	0.3	6	174	2710	0.03	0.02	0.2	15
Pomegranate (pulp)	82.3	65	0.9	0.3	16.4	0.3	0.5	3	8	0.7	3	259	Tr	0.02	0.03	0.3	4
Pistachio nut	5.3	594	19.3	54.0	19.0	2.0	2.7	131	500	7.3	--	972	230	0.70	0.20	1.4	0
Carob flour	11.2	180	4.5	1.4	80.7	7.7	2.2	352	81	5.0	--	950	50	0.03	0.05	2.5	--
Cactus pear (fruit pulp)	85.0	38	0.5	0.1	11.0	1.8	1.6	60	34	0.8	0.8	161	40	0.01	0.02	0.3	30
Loquat	86.5	168	1.4	0.7	43.3	0.9	--	70	126	1.4	--	348	2340	--	--	--	3

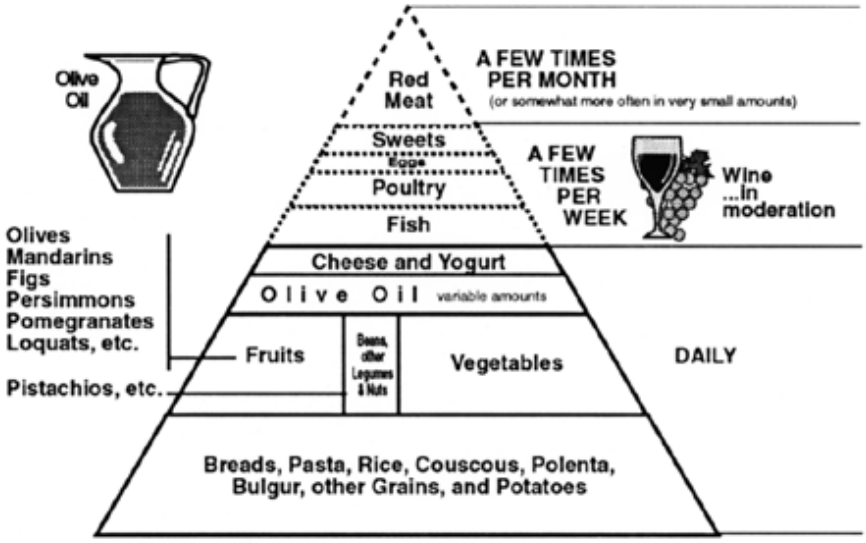

Fig. 1. This Mediterranean Diet Pyramid was co-developed and jointly released in 1994 by Oldways Preservation & Exchange Trust, the World Health Organization (WHO) European Regional Office, and the WHO/ FAO Collaboration Center in Nutritional Epidemiology at Harvard School of Public Health.

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