

A national value: Turkish figs

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Introduction

Figs are predominantly grown in countries that are dominated by a Mediterranean climate. Although fig plantations are widespread in Turkey, there are variations in soil and climate conditions among the growing regions. The ideal conditions for dried fig production are: temperate and rainy winters, 30-40°C summer temperatures especially in July-September, 45-50% relative humidity, alluvial, clayish-loam soil, and an average annual precipitation of around 650 mm (Ozen et al., 2007). When the famous Turkish fig cultivar, 'Sarılıp', is grown in the Büyük and Küçük Menderes basins of the Aegean region, where the climate and soil conditions meet these desired criteria, some of the best quality dried figs in the world are produced. Fig production is carried out mainly in Aydın, Bursa, İzmir, Mersin, Hatay, Balıkesir, Antalya and Gaziantep provinces in Turkey (Figure 1). In recent years, there has been an increase in fig production in both the Adana province and Çukurova basin. Aydın province accounts for 62 and 75% of fresh and dried fig production, respectively (Arpacı, 2017).



Figure 1. Fig cultivation areas in Turkey (listed in white text).

Almost all of the dry fig cultivation in Turkey occurs in the Büyük and Küçük Menderes basin (Cobanoğlu, 2013). Fifty to sixty years ago, fig production was carried out mainly on the lowlands (Figure 2), however, with the removal of fig trees from these flat areas for other purposes, the majority of fig production has shifted to slopes and mountainous terrain (Figure 3).



Figure 2. A young fig orchard planted in lowland conditions in the Aydın province



Figure 3. Fig production areas and drying tunnels in the Nazilli district.

Poor soil structure and erosion are the most important problems in fig cultivation in the mountainous areas. In this regard, it has become necessary to develop soil and water preservation techniques. In lowland areas, first olives and citrus, and then pomegranates, plums and corn, have been tried as alternatives to fig cultivation, but none of them have survived for long. At a conference held in 1955 on the theme of fig, it was recommended that the fig trees should not be removed, despite all the difficulties. The participants recognised that figs had been cultivated in these ecological locations for over 2500 years. Herodotus, who was an historian living in the Bodrum county of Turkey in the fifth century BC was quoted as saying “*fig culture is as old as human history*”, and that “*the reason Persians gave up their fighting in the battle was lack of fig in their foods*” (Ureten, 2014).

Fig production and trade

Figs have been produced commercially in the Large and Small Menderes valleys for nearly 200 years. Turkey ranks first in the world in terms of fresh fig production, and is followed by Egypt, Algeria, Morocco and Iran (Table 1). Turkey produced 26% of the world production in 2014, whilst Egypt, Algeria and Morocco produced 16, 11 and 11%, respectively. Turkey is also the number one producer of dried figs (Table 2).

Table 1. Fresh fig production in the world (t) (FAO, 2014).

Country	2011	2012	2013	2014
Turkey	260,508	274,535	298,914	300,282
Egypt	165,483	171,062	153,089	176,105
Algeria	120,187	110,058	117,100	128,620
Morocco	114,770	102,694	101,989	126,554
Iran	75,927	78,000	78,392	72,672
Syria	42,944	41,224	46,443	35,301
Spain	28,993	24,900	30,400	28,896
USA	35,072	35,072	26,212	30,300
Tunisia	26,000	25,000	23,500	27,000
Portugal	17,812	18,000	17,581	14,728
Others	225,001	212,644	223,832	197,272
World total	1,112,697	1,093,189	1,117,452	1,137,730

Table 2. Dried fig production in the world (t) (INC, 2018).

Country	2016/2017	2017/2018
Turkey	72,000	78,200
Iran	22,000	18,000
USA	9,000	9,500
Afghanistan	7,000	9,000
Greece	7,500	7,500
Spain	5,500	6,000
Italy	3,500	4,000
Others	5,000	3,500
World total	131,500	135,700

In recent years domestic and international trade of fresh figs has been increasing (Sahin and Ucar, 2014). For the last 30 years there haven't been any large increases in the total area of figs, number of fig trees or total fig production in Turkey. In 1990, 300,000 t of figs were produced from 10,443 fig trees, and in 2013, 299,000 t were produced from 10,500 trees. However, export volumes have increased significantly, and this has resulted in greater incomes. Approximately 70% of fresh figs produced in Turkey are utilized for drying. According to the İzmir Commodity Exchange, dry fig production was estimated to be 80,000 t in 2017.

In terms of export quantities, in 1991, about 32,000 t of dried figs and 3,000 t of fresh figs were exported and approximately 66 and 4 million US\$ income was obtained, respectively

(Sahin and Ucar, 2014). By 2014 dried fig exports had risen to 76,000 t, worth 253 million US\$ (Anonymous, 2017; Figure 4). While Turkey has exported most of its figs to EU countries, in recent years Russia, the Far East and the Arab countries have become significant export destinations. Whereas 10 years ago China imported very small amounts of figs, in the 2013-2014 season, it purchased more than 4,000 t (Anonymous, 2017). Given China’s large population, it could become a very important export market for Turkish figs. In terms of dried figs, Turkey has almost no competitor in the world markets. However, in terms of fresh fig production, countries such as Israel, Italy and Spain are becoming important competitors.

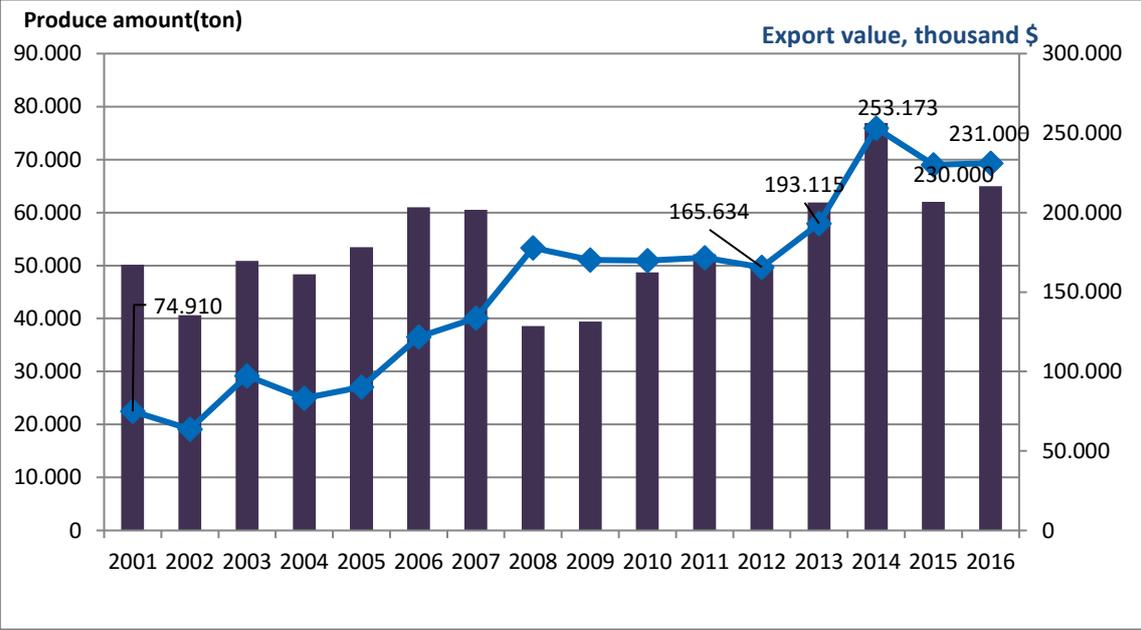


Figure 4. Dried fig export quantity and value from Turkey (Anonymous, 2017).

Fresh fig exports have increased in the last 10 years, particularly from Bursa. In 2005, 9,500 t of fresh figs were exported at a value of 12.5M US\$, whereas, in 2016, 18,000 t of product were exported at a value of 45M US\$ (Figure 5).

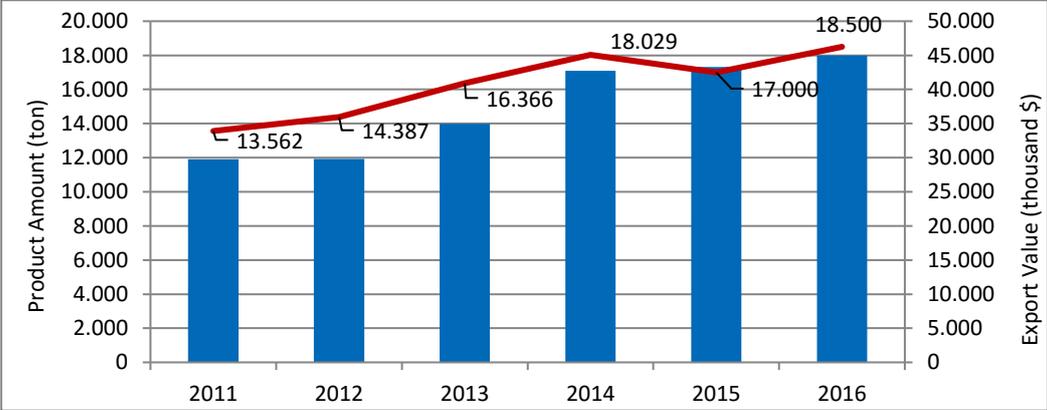


Figure 5. Fresh fig export quantity and value from Turkey (Anonymous, 2017).

Fig cultivars

The Turkish traditional figs are still considered to be some of the highest quality figs available. The cultivar ‘Sarılop’ accounts for 90% of dried fig production grown in Turkey (Figures 6 and 7).



Figure 6. Fresh fruit of ‘Sarılop’.



Figure 7. Sarılop fruits at the fresh fig festival in Buharkent, Aydın district.

‘Sarı Zeybek’ (Figure 8) in Nazilli region, ‘Bardacık’ in İzmir region and ‘Akça’ in Germencik area, are grown as local cultivars. Other cultivars used include ‘Keten Köyneği’ in the Şanlıurfa region for both dried and fresh figs, ‘Halebi’ and ‘Sultani’ in the Gaziantep region for dried figs, ‘Melli’ in the Burdur Bucak region for both dried and fresh figs, and ‘Mut’ in the Mersin Mut region. The dried figs (‘Sarılop’ and ‘Sarı Zeybek’ cultivars) produced in Turkey have unique qualities, including a soft texture, natural color, honey flavor and pleasant smell. Figs from Iran have a harder texture, and from Greece are smaller and

whiter colored, than those from Turkey. For these reasons, Turkish figs have maintained their leading position in the world markets.



Figure 8. Ripe fruit of 'Sarı Zeybek'

Among the fresh cultivars of Turkey, the cultivar 'Bursa Siyahı' (Figure 9) is at the forefront, with its high yield, big size and long shelf life, and this has become one of the major sources of income for the producers. 'Bursa Siyahı' figs make up the vast majority of Turkey's fresh fig exports.



Figure 9. Ripe fruit of 'Bursa Siyahı'

The properties of fig cultivars produced in Turkey are presented in Table 2. The local cultivars, ‘Sarı Zeybek’ and ‘Divrek Kara’, were submitted for cultivar registration in 2017, because of their good drying properties. Among these cultivars, ‘Divrek Kara’ is especially in demand by the consumers because of its dark-color, low sugar content and antioxidant activity, which is about 2.5 times higher compared with yellow cultivars. ‘Sarı Zeybek’ is preferred as dried fruit for its lighter color and small ostiol width.

Table 2. Some characteristics of important fig cultivars produced in Turkey.

Cultivars	Fruit weight (g)	TSS (%)	Skin color	Inner color	Form of consumption
Sarılop	59-70	23.2	Yellow	Light pink	Dry-Fresh
Morgüz	60-70	22.6	Greenish purple	Red	Fresh
208	47-55	22.2	Purple	Red	Fresh
Yeşilgüz	47-55	21.8	Green	Red	Fresh-Dry
Sultan Selim	41-50	22.5	Greenish yellow	Red	Fresh
Bursa Siyahı	66-75	22.6	Black	Red	Fresh
Beyaz Orak	78-100	23.6	Yellowish green	Light pink	Fresh
Siyah Orak	29-40	23.1	Black	Light pink	Fresh-Dry
Divrek Kara	43-50	23.9	Black	Red	Dry

Orchard establishment

Fig orchard establishment in Turkey begins with the planting of single leader trees, which have been propagated from cuttings, have 10-15 mm diameter and are 70-90 cm in length (Figure 10). In preparation for planting, land is usually tilled 20-30 days after autumn rains. On flat land, trees are planted at 7×7 or 8×8 m spacings for dried fig plantations, or at 6×4 m spacings for fresh fig plantations. On slopes and highland regions, trees are usually planted at 6×6 m spacings because the trees develop smaller canopies. New orchards in Aydın district are usually planted from the second half of November to the first half of December after autumn defoliation has occurred. In cold regions, delaying planting of new orchards until February can be beneficial. After planting, canopy development is encouraged by heading the trees at 70-80 cm.



Figure 10. Fig saplings ready for planting.

Orchard management

- **Fertilization, irrigation and soil preparation**

Production of dried figs in the Aydın region is generally carried out without inorganic fertilization. The majority of Turkish figs are cultivated in soils with low nutrient content, and can be grown without the need for chemical control of pests and diseases. However, in some production areas the soils are sandy and contain lime. In such areas, soil analysis needs to be carried out, and where required, nutrient supplementation undertaken. In the years when the annual precipitation is less than 600 mm, or in very permeable sandy soils, irrigation is required. Using underground irrigation systems is very important for reducing evaporation for dried fig cultivars. Winter irrigation is recommended if the rainfall is less than needed. Tillage is recommended 3-4 times per year in the cultivation of dried figs, for weed control, soil ventilation and rainwater storage, preferably in November, March and June. For the prevention of erosion on sloping terrain, tillage should be carried out as little as possible, but if it becomes necessary, in non-precipitation periods and following the contours of the slope (Aksoy, 2016).

- **Pruning**

Generally, training of young trees follows “modified leader” or “goblet” systems. Trees are shaped as 3 or 4 main leaders and the canopy is created around these leaders. Dried fig cultivation areas are generally warm and dry in the summer, thus development of the main branches in the juvenile period of the tree will prevent sun burn. In sloping or mountainous areas, where the altitude is 500 m or above, multi-leader training is recommended. Because each cut has the potential to change the growth of the tree, no branch should be removed without a reason. Removing branches more than needed can cause fruit quality losses in dried fig cultivation. On the contrary, leaving too many shoots and branches during annual pruning also causes fruit to be small and of poor quality because of excessive crop loads. Fig rootstocks tend to produce suckers, so these should be removed at the beginning of the growth period. Rejuvenation pruning of old trees can be applied by removing main branches as needed.

Pollination and Fruit Formation

The fig fruit is actually a syconium, a fleshy hollow receptacle with multiple ovaries. There are two types of fig trees; male trees (or caprifig trees) and female trees. Caprifig trees have inedible fruit from which pollen is used to pollinate edible figs, hence they are considered to be male trees. Female trees produce edible fruit, although they have both male and female flowers. Important Turkish fig cultivars such as ‘Sarilop’, ‘Bursa Siyahı’, ‘Yeşilgüz’, ‘Morgüz’ and ‘Göklop’ are female trees and require cross-pollination for fruit set, which is carried out by the caprifig wasp named *Plastophaga psenes*. *P. psenes* lives in the fruit of caprifig trees. Mature wasps carry pollen with their wings and feet from the male flowers in the caprifig to female fruit through the ostiole hole. The ostiole is the opening of the involuted fig inflorescence through which the fig wasps enter to pollinate. In male trees (caprifig), three different fruit types are formed in three periods that contribute to the life cycle of the wasp. The first fruit are formed in September-November, the second occur in February-April and are called ‘caprifig’, and third and the last fruit in a season are formed in May-June. A ripe caprifig fruit (last half of May-first half of June) is sized like a large hazelnut, matt green colored, and consists of 170-1300 gal flowers (female flower) and 40-220 male flowers.

The main fig crop forms on current year’s shoots, which emerge in May. In contrast, breba fruit develop on one-year-old shoots in March-April, and these fruit mature in the second half of June in Aydın province conditions, as observed in cultivars such as ‘Siyah Orak’, ‘Beyaz Orak’, ‘Horasan’ and ‘Yediveren’. These cultivars also form fruit in summer. In some cultivars like ‘Beyaz Orak’ pollination by the caprifig wasp is not needed for fruit set in June, whereas in August insect pollination is obligatory. On the other hand, ‘Siyah Orak’ (Figure 11) does not need pollination for fruit set in either June or August. These cultivars are considered as parthenocarpic because their fruit develop without pollination and they have no seeds.



Figure 11. Fruit of ‘Siyah Orak’

In Turkey, pollination of fig (caprification) is usually carried out in the first half of June. Caprifigs are harvested in the early hours of the morning (Figure 12) and put into a net bag containing 3-4 fruit. Three of these bags are hung on each female fig tree so the caprifig wasps can transfer the pollen to the female figs. This process is repeated at least twice at an

interval of approximately one week. Chemical pest and weed control, hanging pheromone traps and tillage should not be carried out during the caprification period. Some caprifigs may carry diseases, thus, usage of healthy caprifig fruit for pollination are effective on the quality of summer fruit. Selection of healthy fruits for caprification is an effective method to prevent diseases in the fruit.



Figure 12. Caprifig fruits for sale.

Harvesting and drying of figs

Harvesting of figs for drying takes about 8 weeks. In the ‘Sarilop’ cultivar, the fruit ripen (semi dry, with 40-50% moisture content) on the tree and drop spontaneously to the ground. Fallen fruit are collected 2-3 times a week and brought to a suitable area for drying. Harvesting should be performed at frequent intervals. The drying process is carried out on plastic drying trays called kerevet (Figure 13) for 2-3 days, until the water content drops to 22-24%.

Figure 13. Traditional fig drying in wooden trays.

In order to make the drying process faster and healthier, it is beneficial to dry the fruit under a plastic tunnel in which two sides are covered by a net (Figure 14). Once dried, the fruit are transported to wholesaler or growers’ warehouses immediately. The warehouses are normally built in cool locations without sun, and have dry air flow and odorless environments. Windows and other open areas are covered with nets. The dried figs must be kept out of contact with the ground.



Figure 14. Drying figs under tunnels.

Fig cultivation in Turkey is practiced almost without use of chemicals for pests and diseases. Especially in the lowland conditions, dried-fruit beetle (*Carpophilus hemipterus*) and fruit flies (*Drosophila* spp.) have been widespread for some years, but they are controlled using natural traps rather than chemicals. *C. hemipterus* and *Drosophila* spp. cause unwanted spoilage in mature fruit. The fungus *Fusarium moniliforme* can affect the inside of the fruit and this can also occur when a diseased caprifig is used for pollination.

Processing and value-added products

Considering the historical importance and consumption trends, figs, especially dried figs, are a very important traditional food in Turkey (Figure 15). Fresh and dried figs can be processed into many different products. These products are mainly jam, marmalade, syrup, fig paste, candy and Turkish delight (Konak, 2010).



Figure 15. Natural dried figs of 'Sarilop'.

Fig fruit are one of the superior sources of minerals, especially potassium and calcium, polyphenols and crude fibers. The process steps employed in the fig enterprises are fumigation, sizing, selecting and removing aflatoxinous figs under UV light, washing, drying, packaging, storage and delivery (Figures 16-18). Fumigation is carried out to eliminate pests that arrived on the fruit prior to harvest. The dried fruit industry in Turkey generally uses approved chemicals or physical methods, such as shock treatment at -40°C , for fumigation. Aflatoxins are mycotoxins produced by two species of *Aspergillus* (*A. parasiticus* and *A. flavus*) and vary from 0.7 to 1.3% in figs produced in Turkey (Konak et al., 2017). In the

afatoxin screening process, the figs are examined under dark room conditions under a 365 nm UV lamp and bright greenish-yellow fluorescence fruit are removed. Then the figs are washed with 5-6% saline at 50-60°C to remove physical impurities. After washing, 60°C air is used in tunnel or cabinet type dryers at a flow rate higher than 2 m s⁻¹ to dry them and to reduce the moisture content of figs below 26%. Then the hand-shaped figs are packaged and stored. Optimum dry fig storage conditions are +4°C and 55-60% relative humidity in cold storage rooms (Ozen et al., 2007).



Figure 16. Separating possible aflatoxin-containing figs under UV light.



Figure 17. Selecting and sorting in fig enterprises.



Figure 18. Washing stage of dried fig processing.

Targets and R&D studies

Although Turkey seems to be unrivaled in the world in both dried and fresh fig production, Turkish growers and marketers would like to increase fresh fig export quantity and price. Using existing cultivars, there is potential to triple exports of fresh figs by improving the packaging, promotion and cold chain conditions.

To achieve this goal, and to improve the whole value chain in general, R&D studies are needed, particularly to develop alternative cultivars that extend the market window. Fig harvesting can be undertaken between June and November because of the diverse fig germplasm and the range of climatic conditions within Turkey. With greenhouse cultivation, it is possible to provide fresh figs to the markets 30-40 days earlier or 20-30 days later than from outdoor production. There are many countries in the fresh fig market during August, which ship their products to Europe and Far East countries in competition with Turkey. Also, many demands come from foreign and domestic markets for dried black figs and seedless cultivars, both fresh and dried. In particular, R&D studies on black-dried, seedless-dried and table fig cultivars should be initiated as soon as possible. The characteristics of the cultivar ‘Sarılöp’, such as taste and flavor, thin skin and honey content, could be matched with the taste, large fruit size and high yield of the cultivar ‘Bursa Siyahı’, by crossing or implementing new breeding techniques for development of superior new cultivars.

Although Turkey produces some of the world’s best quality dried figs, this sub-sector is faced with some threats as well:

- Climate change and geothermal energy; with global climate change, untimely rainfall in the growing period, extreme temperatures, and high humid weather conditions adversely affect the production of dried figs. High humidity (55-67%) and rainfall (9.6 mm), which occurred in the first week of August in 2017 and in the second week of the harvest period, negatively affected the dry fig production in Germencik, İncirliova and Efeler regions, resulting in a 20% yield reduction.

- During the fig harvest period, air relative humidity of 45-55% is required for proper drying. This is the most important limiting factor in the production of dried figs. In recent years, many dams have been built around the fig production areas and the irrigated fields near Büyük Menderes have been increased, and these have raised the humidity.

The lack of uptake of agriculture by the younger generation and the labor problem because of the limited use of mechanization are also important problems in fig production.

The Fig Research Institute is one of Turkey's outstanding national R&D facilities established in 1938, and located at the heart of fig industry in Aydın province. Mainly this institute, but also the other horticultural research centers of the Ministry of Food, Agriculture and Livestock and the relevant universities, are undertaking research to deal with above mentioned challenges.

Conclusion

As the wealth of communities rises, the demand for natural and dry food increases. Turkish fig production entails almost no use of pesticides and inorganic fertilizers except in a few minor cases, thus, fig is considered as one of the leading natural foods. Figs are rated as a natural functional food owing to their significant dietary fiber content, high antioxidant capacity and the macro/micro nutrients present in the fruit. In addition, the Far East countries, which have large populations, have relatively recently been introduced to Turkish dried figs, and they are seen as a very big market for export. The price of dried figs has increased consistently over the last five years. The producer's wholesale price for 2013 was 1 \$ kg⁻¹, whereas in 2017 it was 3 \$ kg⁻¹ for dried figs. Demand for Turkish dried figs, both in the domestic and foreign markets, is very positive. In particular, when the demand for fresh and high quality dried figs started to increase in the domestic market, the export unit price increased accordingly. There is great potential to improve current fig production in Turkey, but this needs to occur without reducing the quality. This will increase the income level of fig producers, thus, it will continue to contribute much more to the national economy.

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