Chapter 2
Date Palm Status and Perspective in Iran

Saeed Hajian and Zohreh Hamidi-Esfahani

Abstract Date palm is the second most important horticultural crop of Iran after pistachio. It is mostly grown in a southern belt of the country. More than 400 cultivars, among 3,000 named cultivars worldwide, are found in Iran, thus providing a major global date palm gene pool. Recently, a comprehensive National Date Palm Program was established to provide support for all key aspects of the date production industry in Iran. Although most of the plantations rely on traditional practices, the growers have started to improve their old orchards and establish new commercial plantations. In the chain of cultivation practices, pollination is the most important. Accordingly, an electric pollinator has been recently developed to efficiently pollinate date palms. Bunch fading disorder has been the most important obstacle in recent years. Identification studies on domestic genetic resources of date palm began in the 1960s in Iran based on morphological characteristics leading to distinctiveness, uniformity, and stability (DUS) national indices for date palm cultivars. Moreover, scientists have recently begun to develop and employ molecular markers to identify and characterize some elite cultivars. The top ten cultivars are Piarom, Barhi, Zahidi, Sayer, Kabkab, Shahani, Dayri, Halawy, Haji Mohammadi, and Dehdar Moradi. Although the fruit is still harvested according to tradition, there have been rapid developments in postharvest operations. The fungus *Beauveria bassiana* as well as gamma rays were found as efficient alternatives to methyl bromide as a fumigant. Date products in Iran are categorized as semifinished, ready-to-use, date-derived, fermented products and by-products.

Keywords National Date Palm Program • Electric pollinator • Bunch fading disorder • Genetic biodiversity • Beauveria • Irradiation • Date products

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2.1 Introduction

Iran is located in southwest Asia and borders the Gulf of Oman, Persian Gulf, and Caspian Sea. Its mountains have shaped both the political and the economic history of the country for centuries. Iran shares its northern borders with three post-Soviet states: Armenia, Azerbaijan, and Turkmenistan. Iran's western borders are with Turkey in the north and Iraq in the south, terminating at the Shatt al-Arab, which Iranians call the Arvand River. The Persian Gulf and Gulf of Oman littorals form the southern border. To the east lies Afghanistan on the north and Pakistan on the south. With a land area of 1,648,000 sq km (636,000 sq mi), Iran ranks eighteenth in size among the countries of the world (FAOSTAT 2014a).

Iran gains a wide range of climatic conditions. Winters are cold with heavy snowfall and below zero temperatures in the northwest during December and January. In these regions, spring and fall are relatively moderate, while summers are dry and hot. On the other hand, winters are temperate and the summers are very hot, having average daily temperatures in July exceeding 38 °C in the south. On the Khuzestan Plain (south west of Iran), summer heat goes along by high humidity. Iran commonly has a semiarid to arid climate in which most of the annual precipitation falls from October through April. Annual precipitation averages 250 mm or less in the most regions of the country. However, rainfall exceeds 1,000 mm annually and is relatively distributed evenly within the year in the western part of the Caspian Sea. In contrast, some basins of the Central Plateau usually receive 100 mm or less of precipitation annually. A wide range in climatic condition makes it possible to cultivate a diverse variety of crops such as cereals (wheat, barley, rice, and maize (corn)); fruits (dates, nuts such as pistachios, olives, figs, pomegranates, melons, and grapes); cotton; sugar beets and sugarcane; spices, e.g., saffron; raisins; tea; tobacco; berberis (barberry); and medicinal herbs. Nearly, 2,000 plant species are domestically grown in Iran; of these, date palm could be considered as one the most historic one (Flora of Iran 2011).

Date palm is the second most important horticultural crop of Iran after pistachio. It is well adapted to poor soil and water conditions as well as the hot and dry climatic conditions in the southern belt of Iran; hence dates play a prominent role in development and environmental sustainability of oasis landscapes and can contribute to desert rehabilitation.

The exact origin of the date palm has been lost in history; however it is clear that it was cultivated in old Iran as early as 4,000 B.C. in the area which today straddles the boundary between Iran and Iraq. Date palm is appreciated and cultivated because of its high nutritional value, and it serves as an important survival food resource, when the country experiences natural calamities and political strife.

Based on the latest reports of the Ministry of Agriculture (Jihad-e-Keshavarzi), nearly 98 % of date palm plantations are located in the southern belt of Iran. Date palm is grown in 13 of the 31 provinces, among them, Khuzestan, Hormozgan, Bushehr, Fars, Kerman, and finally Sistan and Baluchestan, with more than 95 % of total annual production, are the main producing provinces (Fig. 2.1) (Hajian 2005b).

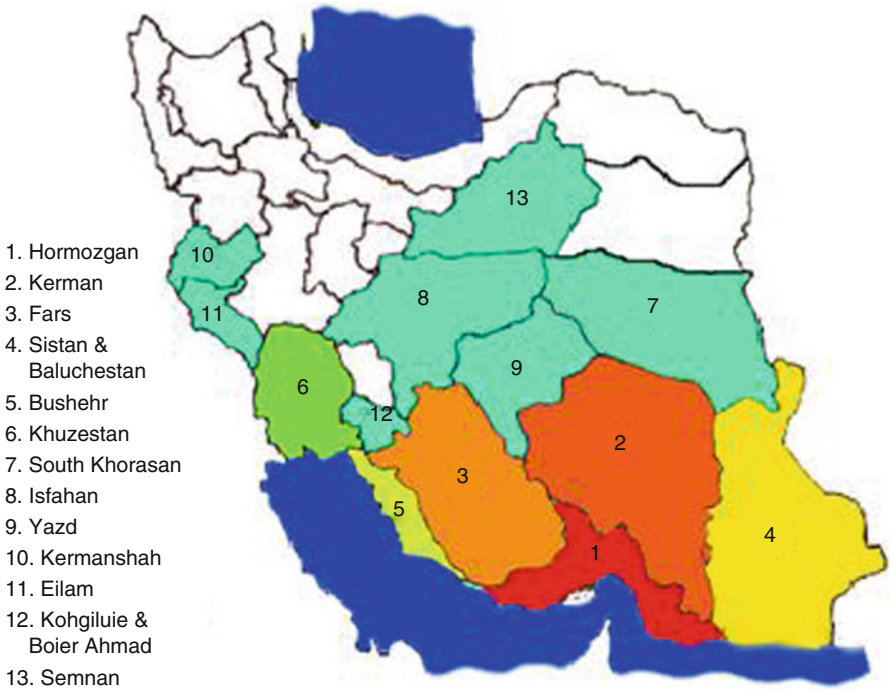

Fig. 2.1 Major (1–6) and minor (7–13) cultivated date palm provinces in Iran (*Source*: Hajian (2005b))

Table 2.1 Ranking of Iranian date industry in the world in 2011

Index	Quantity/value	World rank
Cultivated area	256,000 ha	1st
Harvested area	154,274 ha	3rd
Annual production	1,016,608 mt	3rd
Yield	6.6 t/ha	2nd
Export (quantity)	112, 030 mt	3rd
Export (value)	160.3 million USD	2nd
Germplasm diversity	>400 cultivars	1st

Source: FAOSTAT (2014b)

More than 400 date palm cultivars, among some 3,000 named worldwide, are found in Iran; therefore it occupies the first position in the global date palm gene pool (Zaid and de Wet 2002). In 2011, Iran produced 1,016,608 mt of fresh dates from 154,274 ha harvested; it was the third largest world date-producing country after Egypt and Saudi Arabia (FAOSTAT 2014b). Exports amounted to 112,030 mt of fruit generating a cash return of USD 160.3 million (FAOSTAT 2014b). Table 2.1 reflects Iran's standing as a world date producer. In spite of large-scale cultivation, high production, and a wide diversity of cultivars, the quantity of date fruit exports

Fig. 2.2 Date Palm and Tropical Fruits Research Institute of Iran, Ahvaz City, Khuzestan Province (Photo by Saeed Hajian, Jun 2012)

has been unsatisfactory in recent years. Traditional cultivation and harvesting practices, use of low-yielding cultivars, expensive production costs, insufficient cold storage facilities, traditional packaging systems, high marketing costs, scarce technical knowledge of producers and exporters, insufficient investment by the private sector, competitive global markets, and finally ineffective advertising methods have been key limiting factors in Iran's date industry in the last decades (Hajian 2011).

Research programs on dates commenced 50 years ago within Iran in different disciplines including breeding, protection, irrigation, nutrition, plant cultural improvement, and postharvest technology. The Date Palm and Tropical Fruits Research Institute of Iran was established in 1993 (Fig. 2.2) to coordinate and support all national research programs, with headquarters in Ahvaz City, the capital of Khuzestan Province in the southwest. The institute supports seven agricultural research centers in Hormozgan, Kerman, Bushehr, Fars, Iranshahr, Zabol, and Jiroft, as well as ten field stations at Omm-e-Tomeir, Bahookalat, Jahrom, Hajiabad, Zahak, Shabankareh, Shahdad, Azizabad, Aliabad, and Minab. The headquarters has six research departments: Plant Breeding, Agro-technical Improvement, Plant Nutrition and Irrigation, Plant Protection, Processing and By-Products, and Research and Technical Services.

One of the recent achievements of the institute has been the formulation of a comprehensive National Date Palm Program. The program strongly supports key aspects of the date production industry in Iran. To do this, more than 90 private and governmental organizations are collaborating as major stakeholders, among them the following:

- Agricultural Production Deputy, Ministry of Agriculture
- Agricultural Extension Deputy, Ministry of Agriculture
- Plant Protection Organization
- National Center of Agricultural Mechanization Improvement

- National Agricultural Products Insurance Organization
- Customs Organization
- Shahid Chamran University
- Shiraz University
- Nut Exporters Union of Khuzestan Province
- Commercial Date Producers and Exporters

Formulation of the program began in July 2006 by organizing seven technical groups affiliated with the head office. The program was formulated by consultation and presented to all affiliated parties by the Minister of Agriculture in August 2009. The program is subdivided in the following eight categories: Plant Breeding, Plant Agro-technical Practices, Plant Protection, Irrigation, Nutrition, Mechanization, Processing and Packaging Systems, and Policy Management (Hajian 2011).

In conjunction with the comprehensive plan, new date plantations were encouraged to cover key components including feasibility studies, suitability of the site, selection of cultivars to be planted, site preparation, irrigation systems, and technical practices, while financial establishment will highlight the establishment and operational costs and the cash flow statement.

2.2 Cultivation Practices

Most Iranian date palm plantations have been cultivated following traditional practices and with a high density of trees per hectare. Also they are cultivated along with other fruit crops, mostly citrus species. However, in recent years most of the growers have begun to improve their old orchards and establish new commercial plantations based on modern scientific principles (Pezhman 2002). Growers usually perform cultivation practices of pollination, thinning, bunch management, bunch bagging, and pruning.

Pollination is the most important of the agro-technical practices and has been improved in recent years. Pollination development has focused on five key factors: pollinator cultivar, pollination time, minimum quantity of pollen required, pollen density, and pollination method. According to research results, the best male date palm cultivars recommended as pollen sources for some of the commercial cultivars are listed in Table 2.2.

Growers are able to pollinate the flowers 1 week before natural splitting of the spathes until 10 days after it. The effective pollination period (EPP), for instance, varies from 7 days before natural spathe splitting to 10 days after it in Hayani and Medjool cvs., respectively. However studies revealed that the best time for pollination of most commercial cultivars is 1–2 days before natural spathe splitting up to 3 days after it in Iran (Table 2.3).

A few date palm plantations, especially in the south and southeast, are still pollinated by wind, bees, and insects, so-called *natural pollination*. All these regions are characterized by their 100 % seedling date palm populations with about 50 %

Table 2.2 Recommended male date palm pollen sources for pollination of some domestic cultivars

Female cultivars	Recommended male cultivars	Region (province)	Reference
Sayer	Khekri, Ghanami, Verdi, Samesmavi	Ahvaz (Khuzestan)	Eata (1991)
Zahidi	Towarz, Zahidi	Jahrom (Fars)	Zargari (2000b)
Shahani	Shahani	Jahrom (Fars)	Zargari (2000b)
Kabkab	Zahidi	Jahrom (Fars)	Zargari (2000b)
Mozafati	Pollen of Jiroft male stocks	Aziz Abad (Bam)	Ehsani (1986)
Halili	Pollen of stock no. 1002	Minab (Hormozgan)	Samavi (1999)
Haliaei	Khekri, Samesmavi, Sabzparak, Sorkhparak, Zard Parak	Jiroft (Kerman)	Abazarpoor (1998b)

Table 2.3 The optimal time for pollination of some of the commercial cultivars

Female cultivar	Effective pollination period	Region (province)	Reference
Sayer	From spathe splitting to next 4 days	Ahvaz (Khuzestan)	Sayahpoor (1998)
Mozafati	1–3 days after spathe splitting	Jiroft (Kerman)	Abazarpour (1998c)
Shahani	2–4 days after spathe splitting	Jahrom (Fars)	Zargari (2000c)
Kabkab	2 days after spathe splitting	Bushehr (Bushehr)	Farashbandi (2000)

males that lead to low efficiency of fruit production per unit area. Commercial date production, however, needs artificial pollination to ensure desired fertilization and overcome disadvantages of dichogamy. Artificial pollination practices are performed by traditional hand and mechanical methods in Iran. Most growers are accustomed to pollinate their date palms by the following methods:

2.2.1 Placement of Male Strands in Female Inflorescence

The male strands are cut from a freshly cut male spathes and 4–5 strands placed in a lengthwise inverted position, between the strands of the female inflorescence (Hajian 2005a). It is recommended some pollen be shaken over the female inflorescence after placement of the strands. It is also recommended to tie the pollinated female clusters about 10 cm from the outer end in order to keep the male strands in place and avoid entanglement with the female cluster strands during their rapid growth (Fig. 2.3a). This method could be done by a long wood stick for tall trees (Fig. 2.3b). Both the above cases are very common in Khuzestan, Kerman, and Hormozgan provinces.

Fig. 2.3 Pollination by putting few male strands between the strands of female inflorescence in young (**a**) and tall (**b**) trees

2.2.2 Shaking Dried Pollen Grains over Female Inflorescence Using a Fine Cloth Bag

Pure dried pollen grains are shaken over the female clusters using a fine cloth bag (like a stocking) 48–72 h after the male inflorescence splits. The bag is filled and tied to a long wooden pole, then shaken over the inflorescence of tall trees. Depending upon the height of the tree, it is recommended that shaking be repeated 2–3 times to obtain the highest fruit set (Hajian 2005a).

2.2.3 Pollen Bearing Cotton Pieces Between Strands of Female Inflorescence

This is not very common in Iran but is used by few growers. In this method, dried pollen is dusted on a spherical piece of cotton about the size of a golf ball and 1–3 pieces placed between the strands of female inflorescences (Hajian 2005a).

All the above traditional methods of artificial pollination are based on the climbing of the taller palms which is slow and costly operation and needs considerable labor and time to complete. Accordingly, mechanical pollination has become more popular especially in Kerman Province (Jiroft, Bam, and Kahnuj regions) in recent years (Pezhman 2001). The mechanical device is similar to a manual back sprayer (Fig. 2.4).

By repeatedly pressing the air pump, the air is compressed in the air tank. About half of pollen hopper is filled by dry pure or mixed pollen grains, and when the handle is pressed, the compressed air is released and moves through connecting

Fig. 2.4 Mechanical pollinator for date palm

hose. The grains move from the pollen hopper toward the nozzle through connected pollinator pipes and are expelled over female inflorescence. It is recommended that mechanical pollination be repeated twice with a 2–3 day interval. Mechanical pollinators eliminate the need to climb the palms and save labor and decrease accidents. Also, the growers are able to better manage their time for pollination practices; however, they suffer from inconvenience due to the design. It is necessary that two workers perform the operation.

Recently, an electric pollinator has been designed and developed in Iran to facilitate pollination practices in date palms. The dispersing system is completely different from the previous designs. It can be easily operated by a remote control (Fig. 2.5a). Thus the pollination feasibility and controllability have been enhanced for the operation. The size and weight of the tool as well as operation cost and time reduction with the electric pollinator is superior in comparison with former mechanical pollinators (Fig. 2.5b). Preliminary evaluation of the tool performance on Barhi cv. in the Ahvaz region showed no significant difference between the fruit set of trees pollinated by either traditional or mechanical methods. Mean fruit set attained by the developed tool, mechanical pollinator, and traditional method was 68.12,

Fig. 2.5 Electric pollinator with small remote-controlled dispersing system (**a**) facilitates pollination practices in date palm plantations (**b**)

Table 2.4 Recommended pollen density for pollination some of the commercial cultivars

Female cultivars	Recommended density	Region (province)	Reference
Sayer	20 % pollen + 80 % pollard	Ahvaz (Khuzestan)	Eata (1988)
Kabkab	20 % pollen + 80 % pollard	Kazerun (Fars)	Zargari (2000a)
Shahani	20 % pollen + 80 % pollard	Jahrom (Fars)	Zargari (2000a)
Mozafati	10 % pollen + 90 % pollard	Jiroft (Kerman)	Abazarpoor (1998a)

62.04, and 64.94 %, respectively (Mostaan et al. 2010). The electric pollinator can hold 200 cm^3 of the pollen mixture sufficient to pollinate about 120 palms (about 1 ha) and can be done by a single worker.

Although the growers consider 15–20 male trees/ha in traditional date plantations of Iran to provide naturally enough pollen grains, research over the past 20 years has showed that it could be decreased to five male trees/ha if collected pure dried pollens are mixed with an inert filler substance (Table 2.4).

The particle size of inert filler materials (such as talcum powder, wheat pollard, and ground date bunch remains) must be similar to the pollen grains with no harmful effect on pollen viability or their germination on female stigma.

2.2.4 Pests, Diseases, Disorders, and Weeds

Bunch fading disorder has been the most important problems of Iran date palm plantations in recent years. This disorder was first reported from Kahnodge City in Kerman Province on Mozafti cv. in 1988 and gradually spread to other provinces such as Hormozgan, Khuzestan, Bushehr, and Sistan and Baluchistan on Mordaseng, Khasoui, Kabkab, and Mozafti cvs., respectively.

Fig. 2.6 Symptoms of date palm fading disorder on bunches of cvs. (**a**) Khasoui and (**b**) Mozafti

Fig. 2.7 Covering of bunches with aluminum foil (**a**) and wicker baskets (**b**)

This disorder has been observed mostly on soft fruit cultivars during the mid-ripening stage. Sudden wilting of the fruits that finally leads to fruit and bunch drying which are the most important symptoms of this disorder (Fig. 2.6). The disorder takes place so fast (1–2 weeks) usually at khalal stage (Pezhman 2002). Due to economic impact of this disorder, many projects have been implemented in different fields in order to identify its causes as well as control methods.

Based on preliminary studies, several fungi, especially the asexual forms of *Ceratocystis* spp., have been isolated from infected fruit bunches in different regions; however, their pathogenic effects have not been proven (Karampour 2001a). It was observed that the environmental factors have more influence on the incidence and spread of this disorder than the other factors. It seems that a sudden drop in relative humidity (<20 %) and high temperature (>43 °C) along with hot and dry winds during fruit growth development (from khalal to rutab) have significant effects on higher incidence and development of this disorder (Karampour 2001b). Also, poor attention to appropriate agro-technical practices in date palm plantations plays a key role in exacerbating the level of damage (Mirzaee and Saei 2001).

According to the latest findings, covering of bunches with aluminum foil or a wicker basket reduces the damage (Fig. 2.7) (Pezhman 2002). In addition, cultivation of sorghum or alfalfa in infected plantations significantly improved damaged fruits (Darini and Ezadi 2001; Davoodian et al. 2001).

Table 2.5 The most important pests, diseases, disorders, and weeds of date palm in Iran

Pests	Diseases	Disorders	Weeds
Oligonychus afrasiaticus	*Mauginella scattae*	Bunch fading	*Imperata cylindrica*
Ommatissus binotatus	*Graphiola phoenicis*	Black nose	*Cynodon dactylon*
Batrachedra amydraula		Bastard offshoot	*Alhagi camelorum*
Arenipses sabella		Top bending	*Prosopis* spp.
Oryctes elegans			*Cyperus rotundus*
Parlatoria blanchardi			*Convolvulus arvensis*
Pseudophilus testaceus			*Glycyrrhiza glabra*
Microcerotermes diversus			*Sorghum halepense*
Rhynchophorus ferrugineus			*Amaranthus retroflexus*
Vespa orientalis			*Chenopodium album*
Polistes hebraeus			*Sonchus oleraceus*
Rattus rattus			*Xanthium strumarium*
Nesokia indica			*Malva sylvestris*
Mus musculus			*Solanum nigrum*

Source: Pezhman (2002)

The results of implemented research on this disorder revealed that the level of damage could be decreased significantly from 45 down to 5 % if growers perform integrated agro-technical practices including sufficient nutrition (particularly K_2O spraying with 0.5 % solution at 2, 4, 10, and 15 weeks after pollination), regular irrigation (4–7 day intervals from fruit set to the middle of rutab stage), and bunch pruning (cutting one third of bunch tip) (Pezhman et al. 2005). Other important Iranian pests, diseases, disorders, and weeds in date palm plantations are listed in Table 2.5.

2.3 Genetic Resources and Conservation

Plant genetic resources, water, and suitable land (soil) could be considered as fundamental to support sustainable development agricultural programs in Iran. Research activities have focused largely on prominent genetic resources due to limitations in suitable water and soil conditions in the country.

Investigations of domestic genetic resources of date palm began in the 1960s in Iran. Date cultivars have been developed over thousands of years by seedling selection and propagation of those palms possessing desirable fruit characteristics. Date palm cultivars number around 3,000 worldwide; meanwhile there are more than 400 different cultivars in Iran, placing the country first in the world in that regard.

Accurate identification and conservation of new date palm cultivars has always been of research interest to assess their value as genetic resources. The first Iranian field collection of date palms was established in Khuzestan Province, southwestern

Table 2.6 New identified and collected female cultivars of date palm in Iran

No. of identified female cultivars	No. of collected female cultivars	Province
114	25	Hormozgan
67	130 (Bam) and 150 (Jiroft)	Kerman
85	40	Fars
115	30	Bushehr
33	14	Sistan and Baluchestan
65	105 (Ahvaz)	Khuzestan

Source: Hajian et al. (2011)

Table 2.7 Major date palm cultivars in Iran

Province	Cultivars
Hormozgan	Piarom, Mordaseng, Khasi, Almehtari
Kerman	Mozafti, Kalute, Mordaseng
Fars	Shahani, Kabkab, Khasi, Zahidi, Gantar
Bushehr	Kabkab, Shahabi, Zahidi
Sistan and Baluchestan	Mozafti, Rabbi
Khuzestan	Sayer, Barhi, Zahidi, Dayri, Halawy, Khazrawi, Braim, Khasi, Kabkab, Gantar, Haj Ghanbari, Shekar

Source: Hajian et al. (2011)

Iran, in the early 1960s; three additional collections were created in the early 1980s within the Ahvaz, Bam, and Jiroft agricultural research stations (Hajian and Pezhman 2004). The number of newly identified and collected female cultivars of date palm is shown in Table 2.6. In addition, the major domestic cultivars by province are listed in Table 2.7 (Hajian et al. 2011).

The first foreign cultivars, including Deglet Noor, Medjool, and Thoory, were imported in 1986. These cultivars have been monitored for 15 years for the uniformity of plantlets (propagated by tissue culture), and their quantitative and qualitative fruit characteristics. Results revealed that Thoory cv. is tolerant of high relative humidity and could be recommended for the southern belt of the country (Hormozgan Province), which experiences high relative humidity throughout most of the fruiting season.

Medjool has exhibited desirable fruit quality and quantity; however, Deglet Noor demonstrated low-quality fruit production, probably due to special pollen requirements (Hajian and Pezhman 2004). Other imported cultivars are listed in Table 2.8.

Jarvis no. 1 and Fard no. 4 male cultivars as pollinators were imported at the same time. They are being studied at the Ahvaz (Khuzestan), Minab (Hormozgan), and Zahak (Sistan and Baluchestan) agricultural research stations.

Although the selection and conservation of elite cultivars by creating traditional genetic resources collections, to support rehabilitative programs of old date palm plantations as well as establishment of new ones, these collections do not provide sufficient quantities of propagation materials. Traditional genetic conservation of

Table 2.8 Distribution of imported commercial cultivars in agricultural research stations of Iran

Cultivars	Agricultural research stations (province)
Ashrasi	Khuzestan, Hormozgan, Sistan and Baluchestan
Koosh Zabad	Kerman, Hormozgan, Sistan and Baluchestan, Fars, Bushehr
Abu Narenja	Hormozgan, Sistan and Baluchestan, Fars, Bushehr
Deglet Noor	Khuzestan, Hormozgan, Hormozgan, Kerman
Helali	Kerman, Hormozgan, Fars, Bushehr, Sistan, Baluchestan
Abu Moaan	Hormozgan, Sistan and Baluchestan, Fars, Hormozgan, Bushehr
Hayani	Khuzestan, Bushehr
Medjool	Khuzestan, Hormozgan, Hormozgan, Kerman
Fard	Kerman, Hormozgan, Sistan and Baluchestan, Fars, Hormozgan
Nabat Seif	Hormozgan, Sistan and Baluchestan, Fars, Bushehr
Raana Tala	Kerman, Hormozgan, Sistan and Baluchestan, Fars, Bushehr
Shi Shi	Khuzestan, Kerman, Hormozgan, Sistan and Baluchestan, Fars, Bushehr
Thoory	Khuzestan, Hormozgan, Sistan and Baluchestan, Fars, Bushehr

Source: Hajian and Pezhman (2004)

date palms is threatened by such factors as nonagricultural land development in centers of origins, desertification, climate change, and salinization.

The high maintenance cost of traditional field collections represents a continuous challenge to conserving genetic diversity of date palm; an alternative is to establish in vitro collections to facilitate access and utilization of date palm germplasm. Preliminary conservation efforts have been initiated in recent years in Iran (Hajian 2005c); however, advanced studies are required to identify, characterize, and evaluate the date palm germplasm. This is vital to achieving a rational and successful utilization of date palm genetic resources. Meanwhile, date growers and research centers should still be encouraged to continue conserving elite cultivars traditionally in the oasis cultures.

2.4 Plant Tissue Culture

Mass propagation of date palms from mature specimens is impossible due to the limited number of offshoots produced. Indeed, offshoot production is limited to the early period in a date palm's life span. Moreover, seed and offshoot propagation is impractical. Since the early 1980s, many Iranian governmental initiatives have been put forward to restock the lost groves by the private and public sectors. Scientists and governmental policymakers believe that tissue culture should be considered as the best method for mass propagation of date palm.

The first successes with tissue culture were achieved at the Seed and Plant Improvement Research Institute, affiliated with the Ministry of Agriculture, in 1988–1990. Implemented researches mostly focused on Sayer and Kabkab cvs. by embryo culture (Majidi et al. 1991; Nazeri et al. 1993), meristematic tissues

(shoot tips and buds), and highly differentiated somatic tissues (leaf, stem, inflorescence, and root sections). Somatic embryogenesis, based on callus production and multiplication, followed by growth and elongation of somatic embryos, has been mostly applied (Davoodi et al. 2002; Eshragi et al. 2005). Up to now, this technique had shown to be genotype independent with a high rate of multiplication along with a high survival rate upon transfer to soil. Nevertheless, there is always a question among date growers and scientists about the true-to-typeness of plants produced in vitro. At the present time, three groups of tissue culture-derived plants can be found in Iran. On average, their bearing age is 15, 9, and 6 years. Those in the first group were micropropagated and acclimatized abroad and brought into the country at 1985. The second group of plantlets was micropropagated abroad and acclimatized in Iran; those in the third group were micropropagated and acclimatized within the country.

Subsequently, a private joint venture agreement was signed by the government with Date Palm Developments Limited, a UK company, to facilitate the transfer of date palm tissue culture technology to Iran over a period of 3 years. The technology transfer was successfully achieved by 1996 and certified by the parent company. The private sector subsequently acquired whole ownership of the technology and has been producing large numbers of tissue-cultured date palms for over 10 years. It is worth mentioning that tissue culture-derived plants of a few cultivars are subject to somaclonal variation in particular and to genetic variations in general. These are unlike the epigenetic variations observed and reported in Iran, which are at the physiological level. Iranian date growers have experienced various reproductive and vegetative abnormalities on young palms since 2007. Results of a national comprehensive research project revealed that fruit set failure was the leading abnormality throughout the country.

Barhi was found to be the most sensitive cultivar to propagate by tissue culture. Also, younger palms generally showed more reproductive and vegetative abnormalities. According to recent findings, the technique used for propagation (protocol), nature of mother plant (chimera), type of growth regulators used, type of explant used (ploidy gradients: apex to root), age of subcultures (>1 year), medium composition, and incubation conditions are key factors causing the variations (Hajian 2009). In addition, studies by means of enzymatic systems revealed that there were some differences in the isozyme banding pattern of offshoot and micropropagated plants (Zivdar et al. 2008). The polymorphism of peroxidase (PRX) and shikimate dehydrogenase (SHD) enzymatic systems confirmed that the differences distinguished had an epigenetic basis.

Most commercial laboratories in the world are doing their best to ensure the true-to-typeness of the produced date plant material. Various techniques such as histocytology, isoenzyme, restriction fragment length polymorphism (RFLP), and random amplified polymorphic DNA (RAPD) are used to produce and certify the conformity of the plants. In most cases, fingerprinting is the technique actually used, but it is believed that field response is the only reliable test to confirm that palms derived from tissue culture are true to type to the mother plant (Zaid and de Wet 2002). However, the private sector in Iran which is using tissue culture for mass propagation of date palm has not revealed how they certify the true-to-typeness of their produced plants.

Furthermore, genetic transformation in date palm by means of particle bombardment has been studied since the late 2000s in Iran. Studies have involved plant-related parameters including osmotic conditioning of explants, before and after bombardment, type of explants (embryogenic callus and somatic embryo) as well as bombardment parameters like acceleration pressure, bombardment distance and gold particle size (Habashi et al. 2008; Mousavi et al. 2009, 2014). Further efforts to optimize transformation conditions and the integration of useful genes for the improvement of date palm should be considered as prime targets in Iran.

2.5 Cultivars Identification

The biodiversity of date palms has always been one of the most important aspects of the date palm industry in Iran. The large number of cultivars or landraces among date plantations has made it difficult to identify and characterize all cultivars; however, initial studies commenced in early 1960s on the basis of morphological characteristics. Iranian scientists have attempted to identify and characterize the required plant cultivars for cultivation and breeding programs as well as for cultivar-right-protection purposes. All attempts have been implemented on the basis of phenotypic variation to the early 2000s.

Dawson and Kashani, in cooperation with other Iranian experts, first identified 400 different cultivars throughout the country in the 1950s (Kashani 1979). They established the first field collection which included 175 elite cultivars, in Ahvaz. This involved observations of the morphological and physiological characteristics of an unknown cultivar to provide an official description by comparison with appropriate reference cultivars, which can be used to establish its distinctness, uniformity, and stability (DUS). Subsequent studies mostly focused on fruit characteristics such as color, shape, weight, ripening stage, TSS (total suspended solids), pH, etc. Morphological findings based on the International Union for the Protection of New Varieties of Plants (UPOV), system of intellectual property protection, assisted scientists to determine national DUS indices for date palm in 2007 (Sadeghian 2008). Accordingly, about 20–25 of the over 400 cultivars, as the commercial cultivars, were recommended for cultivation in different regions of Iran. Some of them are briefly described in Table 2.9 (Pezhman 2002).

In spite of that, there are increasing technical problems in achieving distinctness from a large number of cultivars in Iran. Phenotypic plasticity is still an obstacle in identification of date palm biodiversity within the country. Hence, the potential of molecular systems for producing reliable cultivar descriptions, which are largely unaffected by the environment, has become increasingly attractive since the mid-2010s. The potential of molecular systems for application in cultivar registration is therefore under careful and active consideration within UPOV. However, it is clear that the power of molecular techniques could potentially allow discrimination between cultivars down to the very small differences of a few base pairs within the genome. Therefore, before their possible introduction, it has been necessary to

Table 2.9 Fruit characteristics and growth locations of important commercial Iranian date palm cultivars

Cultivar	Color (tamar)	Harvest time	Fruit type	Consumption stages	Total sugar (%)	Flesh to seed ratio	Growth province
Piarom	Brown	Oct–Nov	Semidry	Khalal-rutab-tamar	66.5	7.7	Hormozgan
Zahidi	Yellow to light brown	Oct	Semidry	Tamar	63	8.4	Khuzestan
Dayri	Brown	Oct	Dry	Rutab-tamar	58.5	6.6	Khuzestan
Sayer	Light brown	Aug–Sep	Semidry	Rutab-tamar	63	12.6	Khuzestan
Mordaseng	Light brown	Aug	Soft	Rutab-tamar	47.5	8.8	Hormozgan and Kerman
Halawy	Yellow to light brown	Aug	Semidry	Rutab-tamar	58	5.6	Khuzestan
Shahani	Light brown	Sep–Nov	Soft	Khalal-rutab-tamar	50.5	12.5	Fars
Kabkab	Light brown	Sep	Soft	Rutab-tamar	55.5	11.5	Bushehr
Mozafati	Brown	Aug–Sep	Soft	Rutab-tamar	50	13.0	Kerman
Almehtari	Brownish to yellow	Jun	Soft	Rutab-tamar	54	5.4	Hormozgan
Khasoui	Light brown	Oct	Soft	Khalal-rutab-tamar	55	10.4	Fars
Barhi	Light brown	Sep	Soft	Khalal-rutab-tamar	60	10.5	Khuzestan

consider how to ensure that sufficient genetic distance between varieties is maintained to be able to give certainty of continuing protection (Camlin 2003). To mitigate this, Iranian scientists at the Agricultural Biotechnology Research Institute of Iran (ABRII) have recently begun to develop and employ molecular markers, statistical tests, and software to identify and characterize ten date palm cultivars including Sayer, Piarom, Shahani, Kabkab, Mazafati, Barhi, Gantar, Dayri, Zahidi, and Rabbi. They identified specific molecular keys using seven SSR markers. The results also proved that there was different genetic background within Dayri, Rabbi, and Piarom mother trees (Mardi et al. 2010).

2.6 Cultivars Description

Over 400 various cultivars are known in Iran. The wide variation of date palm biodiversity makes it difficult to describe all of them. However, fruit and tree morphology has been used to distinguish the cultivars since the 1960s. Morphological characteristics, especially the color variation during fruit development, supplemented with leaf morphology have shown promising results to individualize the cultivars. From fruit set to full ripened stage, the fruits pass through distinct changes of development beginning with hababouk and ending at tamar. Color variation during these stages is the best diagnostic marker for Iranian scientists to distinguish the cultivars. In addition, shape and size of fruits are good indicators for cultivar identification, although the size is mostly influenced by agro-technical practices. Some Iranian botanists consider the position of the fruit cap (perianth) to characterize a cultivar. The fruit cap entirely covers the fruit base in some cultivars, whereas it covers only the central portion in others. Moreover, seed characters such as shape, size, margin of ventral furrow, and pulp-to-seed weight ratio are used to identify the cultivars. Date palm botanists also consider biochemical composition of fruits such as TSS and pH to determine cultivar description (Hajian 2007). Accordingly, the top ten superior date palm cultivars of Iran are illustrated in Fig. 2.8. In addition, their descriptors are shown in Table 2.10.

2.7 Dates Production and Marketing

Over one million mt of fresh dates currently are produced each year in Iran. Statistics show that 55–60 % of annual production is consumed domestically; 12–16 % is exported, leaving 24–33 % considered as surplus or wasted production. Most date fruits are consumed directly with little or no processing, although the quantity of processed date products is growing rapidly.

According to export statistics of FAO, Iran has typically been the second largest date producer and exporter in the world over the decade 2002–2011. Although export quantities have fluctuated during this period (Fig. 2.9a), the unit value has risen significantly (Fig. 2.9b).

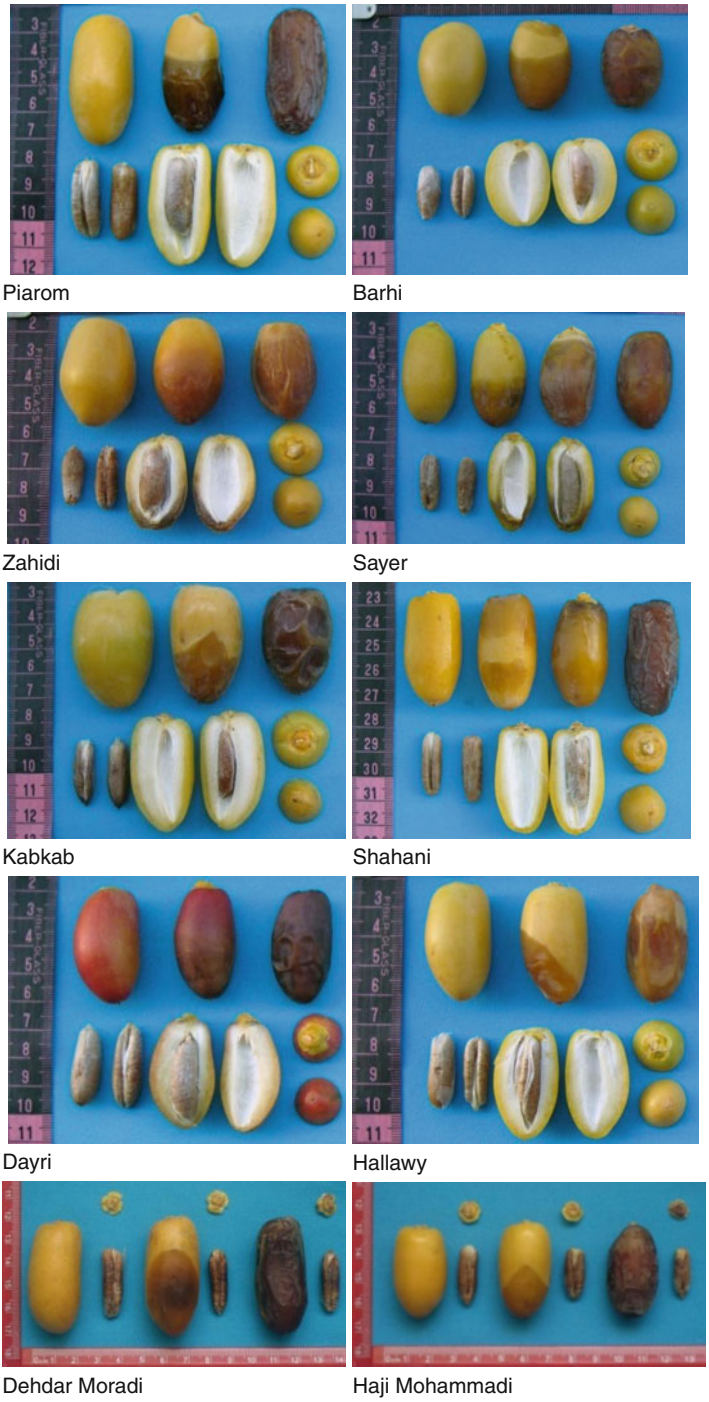

Fig. 2.8 Popular date palm cultivars grown in Iran

Table 2.10 Descriptors of elite date palm cultivars grown in Iran

Cultivar	Average yield (kg/tree)	Max recorded yield (kg/tree)	Tree height[a]	Fruit length (mm)	Fruit diameter (mm)	Fruit weight (g)	Fruit type	Sweetness[b]	Ripening time
Barhi	145 (khalal)	350 (khalal)	Dwarf	35	25	9.8	Soft	Moderate (khalal)	June–July (khalal), Sept (tamar)
Dehdar Moradi	88	110	Tall	51	22	9.7	Semidry	Moderate	July–Aug
Dayri	45	110	Dwarf	35	16	6.5	Dry	Very high	Sept–Oct
Haji Mohammadi	60	85	Tall	43	22	8.8	Soft	Very high	June–July
Halawy	65	135	Semi-tall	41	22	6.9	Semidry	High	June–July
Kabkab	65	95	Semi-tall	33	22	14.8	Soft	Very high	Aug–Sep
Piarom	50	95	Tall	41.5	17	8.7	Semidry	Moderate	Oct–Nov
Sayer	47	100	Semi-tall	40	20	8.0	Semidry	Very high	Aug–Sep
Shahani	91	175	Tall	41	15	11.5	Soft	Moderate	Sept–Nov
Zahidi	75	130	Dwarf	35	20	7.7	Semidry to dry	Very high	Aug–Oct

[a]Height of tree (m): dwarf 2.45–3.64, semi-tall 3.65–4.84, tall 4.85–9.64, very tall >9.65

[b]Sweetness of fruit (total sugar %): low<67.4, moderate 67.5–74.4, high 74.5–77.9, very high 78.0–88.4

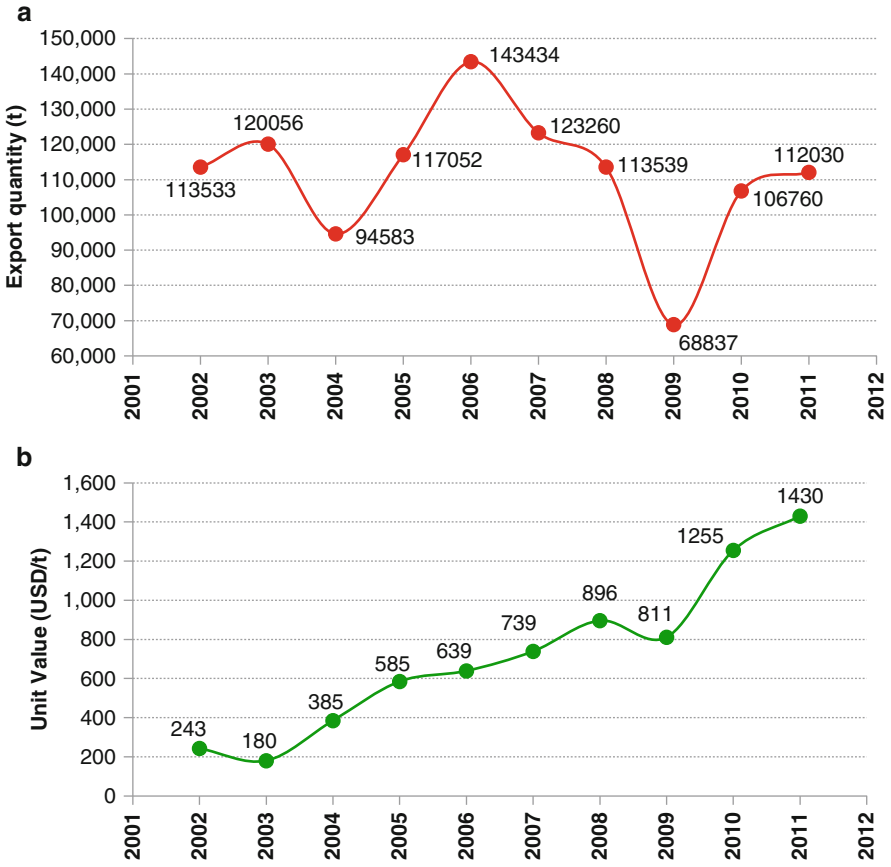

Fig. 2.9 Quantity (**a**) and unit value (**b**) dates export from Iran during the decade 2001–2011 (*Source*: FAOSTAT (2014b))

The knowledge of Iranian date growers about production as well as preservation and storage of dates has improved in recent decades. Since the early twenty-first century, reports indicate that the potential and viability for a modern date industry exists in Iran. Most of these reports focus on economics and marketing of the crop at the national or regional level. Although the fruits are still harvested by traditional methods, there is rapid development in postharvest operations.

Postharvest processing of dates includes sorting, pitting, disinfestation of insects, washing, grading, heat treatment, adjusting moisture content, coating, pasteurization, and packaging. Although most date producers follow the processing steps, the first fully mechanized sorting, disinfesting, and packaging pilot plant was established in Ahvaz in 2010. It was supplemented by global standard cold storage rooms to enhance technological knowledge of both producers and exporters. The pilot plant includes different peripheral devices such as a washing and dryer machine (Fig. 2.10a) and date paste maker (Fig. 2.10b).

Fig 2.10 Date paste maker (**a**) and automatic washing and drying machine (**b**) in the first modern pilot date processing in Ahvaz, Iran

New alternatives for fumigation of fruits by methyl bromide must be considered as one of the recent achievements in postharvest technology in the Iranian date industry. Novel research findings revealed that application of the fungus *Beauveria* (*Beauveria bassiana*) is able to effectively control adult *Oryctes elegans* (Coleoptera: Scarabaeidae) in storage rooms (Latifian and Rad 2012). Moreover, radiation of Sayer date fruits by gamma ray (0.25 KGY) prolonged shelf life of the fruits in storage rooms for up to 9 months. Findings proved that *Plodia interpunctella* and *Oryzaephilus surinamensis* were efficiently controlled by this method of irradiation (Garshasebi 2010).

Nevertheless, growing mixed cultivars, traditional harvesting, a high level of wastes in the plantations, expensive production, low standards of packaging and storage systems, high marketing cost, and ineffective advertising methods should be considered as the key obstacles of postharvest technology of Iran's date industry (Hajian 2011).

2.8 Processing and Novel Products

Industrial producers often sort date fruits in the field just after harvesting. Sorting is usually done manually by workers who cull damaged fruits as well as remove foreign materials. Date processing mostly involves removing the cap and in some cases seeds of the dates for better marketing and reducing transfer costs (Barreveld 1993). Removing date seeds may be done by crushing and sieving the fruits or, more sophisticatedly, by pushing the seed out of the fruit. The next stage involves fumigation and sterilizing the fruit to prevent pest damage when they are stored. In Iran, the major techniques to prevent insect infestation are fumigation, heat treatment, cold storage, and irradiation, of which fumigation is the most common. Heat treatment and cold storage are rather beneficial when applied to dates for other reasons, and

irradiation is an effective but not yet common. Other fumigants are also used such as carbon disulfide, hydrocyanic acid, Phostoxin, and ethylene oxide, but methyl bromide is the most prevalent and effective technology. Nevertheless, it is worth mentioning that the current technique of disinfestation using methyl bromide has been prohibited by the year 2015 (UNEP 1998). Washing is usually done by automatic machines to remove dust or other foreign materials using water sprays. After washing, dates are subjected to flowing warm air to remove the moisture from the surface of fruits (Ashraf-Jahani 2002).

At the next stage, dates are graded according to size, color, and moisture content, after which heat treatment of 60–65 °C as a partial pasteurization is applied to limit the activity of microorganisms, enzymes, and insects. Date drying is carried out by using drying tunnels or solar drying. Dates are subjected to deterioration because of fermentation, mold formation, darkening, and aroma and flavor loss. All forms of deterioration increase with higher water content. Air drying should result in a moisture content of 20 % or less to prevent the activity of molds and yeasts. If dates do not have the recommended minimum water content, artificial hydration may be used. Hydration is carried out for dates that have been dried by remaining on the tree for a long time or in long-term storage. The most common method of hydration is using low-pressure saturated steam. To remove the stickiness of the date surface, starch solution or methyl cellulose is used. Edible oil, water, BHA (butylated hydroxyanisole), and BHT (butylated hydroxytoluene) are used to eliminate the roughness of date surface and make it shiny. Then, pasteurization at 66 °C for 30 min is conducted to complete the process of microbial reduction. Finally, dates are packaged in suitable containers, labeled, and controlled for weight and toxic metals. Subsequently, dates are transferred to cold storage chambers to retard chemical and biological processes (Ashraf and Hamidi-Esfahani 2011).

Many products, such as date syrup, alcohol, animal feed, date powder, different types of bread, marmalade, candy, chocolate, and date paste, can be obtained from dates. Other parts of the tree are also important in the rural economy. For example, the stem is used for making wooden boats and rafts as well as roof coverings for rural houses in addition to serving as raw materials for fiber, paper and wood industries. The foliage is used for making handicrafts such as fans and straw hats. It is estimated that more than 70 various products and by-products can be produced from different parts of date palm.

Date products in Iran are categorized as semifinished date products, ready-to-use date products, derived products from date fruits, fermented products, and by-products from processing (Ashraf and Hamidi-Esfahani 2011).

2.8.1 Semifinished Date Products

Date Paste The production of date paste is one of the most interesting products in the date food industry. It leads to reduced transportation and storage costs, since the seeds (10–20 % of the total fruit weight) are removed during processing. Moreover the

availability of date paste for the food industry is ensured throughout the year. Date paste makes it possible to convert dates of even inferior quality into an intermediate value-added product for the date processing industry. Date paste is usually made from culled fruits unsuitable for marketing. For the preparation of date paste, pitted dates (tamar stage) are either soaked in hot water (95 °C) for 5–15 s or steamed for 3 min at 69 kPa. Dates are turned into date paste by grinding. Citric or ascorbic acid (0.2 %) may be added to lower the pH of date paste for improved shelf life and to maintain a desirable color. Date paste can also be used as a partial substitute for flour in bakery and confectionary products. The use of 4–8 % date paste in bread formulation results in significant improvements in the dough's rheological properties, delays gelatinization, improves gas production and retention, extends the shelf life, retards staling, and improves the crumb and crust characteristics. Using date paste in cookies results in a higher spread ratio increasing with amounts added up to 20 %. It prevents the crystallization of sucrose in cookies during the cooling off period immediately after baking.

Extruded Date Seeded crushed dates are extruded through 0.6 cm holes and shaped into rolls, cut into 1.3–2.5 cm lengths, and coated with dextrose or barley flour to prevent them from sticking together. To improve marketing, it is dried and solidified by exposure to air.

Diced Date This product is made from cutting seeded dates into pieces with a dicer. The diced date pieces are coated with dextrose or oat flour to prevent the pieces from sticking together. This product is usually consumed with cereals, cooked products like cake, different kinds of bread, and sweetmeats. Adding date pieces (10 %) to ice cream slightly reduces the overrun.

Date Powder After dilution of date paste with water, it is spread on metal trays and dried using a tunnel or cabinet dryer until moisture is less than 5 %. The dried material is milled and sold based on different granular sizes. This product is used in confectionary and baby foods as a sweetening agent.

2.8.2 Ready-to-Use Date Products

Some preserved products such as pickles, chutney, jam, jelly, dates in syrup, date butter, candy, and confectionary products are prepared from date. Dates at the kimri and khalal stages of maturity are most suitable for preparing pickles in oil and for chutney. Pickles in oil are prepared using pitted, sliced kimri fruit with various spices, condiments, and mustard oil. Chutney is a generic term for a condiment composed of fruit sugar, citric acid or vinegar, vegetables, and hot spices. Derived from an Indian word, chutney is probably best known when mango is used as the basic fruit, but other fruits such as dates can be utilized. Brine and salt-stock pickles are other popular products that could be prepared from kimri dates.

Ripe dates with a high sugar content are suitable for jam making. A sugar-date pulp ratio of 55:45 is used for jam making with 65 % sugar content, 1 % pectin, and

pH of 3.0–3.2. For jelly making, date juice-sugar at a ratio of 1:1 is used, and the finished product has total soluble solids content of 73° Brix and pH of 3.57.

Also, dates in tamar stage containing high sugar content are appropriate for date butter, which is similar to peanut butter in usage. It is similar to jam making, except the pH is adjusted to 4.7, the total soluble solids content of 75° Brix, and a sugar-date pulp ratio of 40:60.

Dates in syrup is prepared from peeled, seeded whole dates at the khalal stage. In this product, the syrup is concentrated to about 75–80° Brix with the pH adjusted to 2.8–3.0 with citric acid.

Date candy is prepared using date paste, roasted groundnuts, and coconut. The use of date paste and nuts in a 60:40 ratio coated with chocolate gives a good sensory quality for this type of candy. Plain date bars prepared from date fruit, almonds, coconut, groundnuts, and pistachios can be coated with chocolate and fortified with sesame, skim milk powder, and oat flakes.

Different desserts prepared from date fruits are ice cream, pudding, date sherbet, and fruit yogurt. Other products include macerated date and fiber-filled dates, with the former having medical uses. Other ready-to-use date products are different sauces such as steak sauce. Steak sauce is a traditional product, used as a flavor with meat dishes; it contains 10 % ground dates.

2.8.3 Derived Products from Date Fruit and Stem

In this type of production, second grade or culled fruits from large-scale date packing operations are typically used. The product list includes date spread, sherry, medicinal alcohol, arrack (spirits), vinegar, date wine, date syrup, soft drinks, liquid date sugar, and high-fructose liquid date sugar. Dates are mixed with water in all these products to facilitate the separation of undesirable materials. In some products, added water remains in the final product, as in beverages. However, in other products, water is added to create a suitable medium for the next process such as fermentation.

Other products from date syrup are yeasts (rich in protein), vitamins, and also baker's yeast. Fat can be produced from date juice and syrup by means of some microorganisms like *Penicillium lilacinum*, *Pen soppi zaluski*, and *Aspergillus nidulans*. Date pulp and/or date syrup can be utilized as a substrate for oxytetracycline formation by some suitable mutants of *Streptomyces rimosus*. Date seed lipids and hydrolysate can serve as carbon and nitrogen sources, respectively, in the fermentation medium for the formation of oxytetracycline by *Streptomyces rimosus*. Higher amounts of antibiotics were found with date substrates than with glucose and urea.

Date honey is concentrated date juice with colloidal compounds from which the major part of its pigments has been removed. It is utilized in beverages, chocolate, ice cream, marmalade, and confectionary. A kind of syrup can be obtained from the stem tissue sap of some date palm cultivars from which sugar is extracted. Caramel coloring made from date syrup can be used in a variety of foods, such as beverages,

bakery, confectionary, and meat products. Another product is Tarooneh arrack (Tarooneh distillate), which is made from the chopped male or female spathe; it smells pleasant and has medicinal benefits.

Sago (white in color) and *lagmi* (date palm sap) are other products obtained from the date palm stem. Date palm sap (tapped from the stem) has a high sugar content (mainly sucrose), protein, ash, and phenolics. Its surface activity and foaming power are due to the presence of proteins. Because of its antioxidant activity and nutritional value, this natural juice could be used as a functional food. Sap extracted to produce sweet *lagmi* must be done away from sunlight to prevent fermentation.

2.8.4 By-Products from Date Processing

Three major by-products result from date fruit processing facilities: low-grade rejected date fruits, date seeds, and date press cake. Date fruits, unfit for fresh consumption or in derived products, are commonly utilized as animal feed or as a substrate for fermentation products because of their nutritive components such as sugars, proteins, and minerals. Date seeds possess good nutritional value based on their dietary fiber content, making them suitable for the preparation of fiber-based foods and dietary supplements (Habibi-Najafi 2011). Date seeds are also referred to as pits, pips, stones, and kernels. Date seeds represent on average 10 % of fruit weight. Because they are rich in oil, proteins, minerals, and fiber, they can serve as valuable raw materials in animal feed.

Press cake is the by-product of date juice extraction. Depending on the method used for juice extraction, date flesh with remaining sugar, with or without seeds, remains. Press cake is wet (about 70 % moisture) and bulky (it forms 30 % of date weight) and deteriorates quickly; it can create a disposal problem if unutilized. Investigations have revealed that the majority of protein exists in the press cake itself and the majority of fat in the date seed. Press cake which includes seeds is a rich source of dietary fiber and high levels of phenolics and antioxidants. Press cake is utilized for animal feed as well as microbial conversions.

2.9 Conclusions and Recommendations

Iran can be considered as one of the oldest date-producing countries in the world. Historic indigenous knowledge of date growing and large-scale cultivation, high annual production, high yields, and a wide diversity of cultivars have provided inimitable conditions to further develop the date industry. Over one million mt of fresh dates are presently produced annually in Iran. Nearly 55–60 % of annual production is consumed in domestic markets, around 12–16 % is exported, and the remaining 24–33 % can be considered as surplus and wasted production. The same pattern could be found in global domestic consumption, export, and surplus and wasted

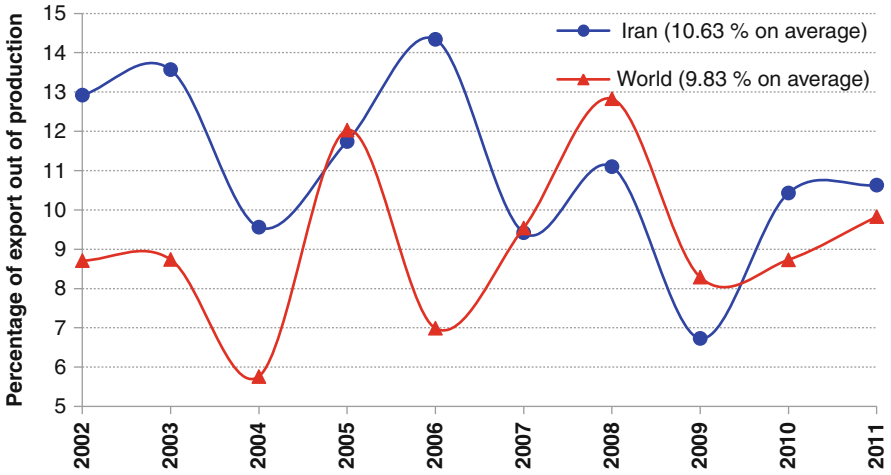

Fig. 2.11 Percentage of date fruits export out of production in Iran and the world

production, according to recent FAO statistics (FAOSTAT 2014b). Fig 2.11 illustrates that 10 % of annual production has been on average exported from Iran and worldwide during decade 2002–2011. Similarly, around 90 % of annual production has been globally consumed (including surplus and wasted production) in domestic markets. Therefore, global market demands are consuming no more than 10 % of annual production.

Efficient and innovative marketing methods must be employed to attract new date consumers. Indeed, the potential value of eating dates is not clearly defined in the daily human diet; most consumers do not consider dates as a fruit in the way they do apples, oranges, or bananas. Dates are also not accepted as a nut snack such as pistachios or peanuts. Moreover, the poorer segments of societies do not consider dates as a desirable food. Per capita consumption in Iran, as well as in the world, confirms the low status of dates in daily human diet. The latest statistics illustrate that average annual fresh date fruit consumption amounted to 11.6 and 0.9 kg per capita in Iran and in the world, respectively, in 2009 (FAOSTAT 2014b). The statistics also revealed that Iran occupies fifth place in per capita consumption of dates after Saudi Arabia, Algeria, Libya, and Egypt with 36.6, 16.3, 16.3, and 14.2 kg per capita per year, respectively. Providing new incentives to consumers by innovation in primary products and by-products can create new markets.

The broad patterns of date cultivation and harvesting, use of higher-yielding cultivars, efficient agro-technical practices, adequate cold storage facilities, modern packaging and transport systems, and inducement of the private sector to invest in the date industry have to be considered as contributory approaches to develop the industry within Iran. On the other hand, programs should be focused on gradual replacement of cultivars with higher-yielding palms, increasing of product prices to financially support the growers and exporters, effective use of mechanization to decrease production expenses, broadening the array of by-product to decrease

waste, and finally creating vigorous private (or governmental) organizations to define high-level policies for marketing targets. Date palm research must focus on quality improvement in production by adopting new and efficient agro-technical practices as well as utilization of biotechnology to achieve objectives in the areas of gene banks and transgenic plants.

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