Chapter 7
Date Palm Status and Perspective in Libya

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Abstract Libyan date palm germplasm represents a heritage of great value both for agriculture and the environment. This chapter analyzes all the aspects of the date palm status in Libya starting from the historical aspect to the current status as well as the results of the recent International Union for the Protection of New Varieties of Plants cooperative program between Italy and Libya for improving and promoting date palm production in Libya, which at present is quite low. All the production is consumed locally, and the cultivation techniques and the processing industry are outdated and need to be modernized. The program strategy was driven by two main objectives: first, identification of high-quality dates through production protocols that ensure the consistency and quality of the final product; second, protection of the agrobiodiversity by promoting local date palm cultivars and strengthening traditional oasis management systems. For this purpose 18 Libyan cultivars, representing common genotypes in the central Libyan oasis of Al Jufrah, were studied in detail both from a morphological and genetic point of view. Cultivar descriptions were carried out on the basis of passport descriptors according to international standards to facilitate germplasm passport information exchange together with genetic fingerprinting. This was performed using 16 highly polymorphic simple sequence repeat (SSR) loci, which allowed setting up an efficient and unambiguous identification system. Clonal fingerprinting and cultivar identification are important elements for promoting typical local products and for linking a product to its place of origin. In this context, the Libyan germplasm represents an enormous richness that

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deserves to be exploited. Its characterization and valorization open new prospects for date palm breeding.

Keywords Agrobiodiversity • Al Jufrah Oasis • Cultivar • Date palm • Desertification • Libya • Molecular genetic diversity • Pomology

7.1 Introduction

The date palm, *Phoenix dactylifera* L., a dioecious perennial monocotyledonous species indigenous to the Middle East and perhaps to North Africa, is one of the world's first cultivated fruit trees (Govaerts and Dransfield 2005; Wrigley 1995). It was domesticated in Mesopotamia more than 5,000 years ago, and it has long been one of the most important plants of arid areas of northern Africa, the Middle East, and South Asia (Sauer 1993). The date palm has been called *the tree of life* because, in harsh environment where relatively few other plants can grow, it provides food as well as material for shelter, fiber, and fuel and it has been used for religious purposes (Carpenter 1975, 1981; Dowson 1982; Nixon and Carpenter 1978; Popenoe 1973). The Arabs have a saying, *the palm is our dear mother (al-umm al-hanuna)*. Only its fruits, wood, and leaves make life in the desert possible. Without date palms, people could not survive in such a harsh environment. Whole civilizations have developed due to the date palm and Muslim populations living in the desert areas attach great importance to this tree and its fruit (Danthine 1937).

The 19th Surah of the Qu'ran tells of the birth of Isa (Jesus) and describes an image full of divine tenderness: the Lord, Allah, comes to the aid of Maryam (Mary) and eases her suffering during childbirth with the fresh, ripe fruits of the date palm:

> And the pains of childbirth drove her to the trunk of a palm-tree: She cried (in her anguish): "Ah! would that I had died before this! would that I had been a thing forgotten and out of sight!" But (a voice) cried to her from beneath the (palm-tree): "Grieve not! for thy Lord hath provided a rivulet beneath thee; "And shake towards thyself the trunk of the palm-tree: It will let fall fresh ripe dates upon thee. So eat and drink and cool (thine) eye. And if thou dost see any man, say, 'I have vowed a fast to ((Allah)) Most Gracious, and this day will I enter into not talk with any human being'." [Surah Maryam, 23–26, translation by Yusuf Ali]

The Muslim tradition has also passed down some Hadiths, sayings of the Prophet, which confirm the importance attributed to the date palm in the life of the universe and humans.

The Prophet Muhammad says that when the end of the world will come, whoever has a date palm offshoot in their hand must plant it, to ensure the continuity of life. When a woman gives birth, the first food that the newborn should eat is a date, because the first to do so was the Prophet Muhammad. In a house where there are no dates, it is said, the inhabitants will suffer from hunger.

Humans have spread the date palm far beyond its historical range, taking it to nearly all tropical and subtropical areas of the world (Zaid and de Wet 2002).

Recent research has revealed how the cultivated date palm is closely related to wild and feral date palm in the Near and Middle East and North Africa. These wild date palms are morphologically similar to domesticated cultivars, share the same climatic requirements, and can hybridize with the cultivars.

From a botanical point of view, wild and feral dates are considered the same species (Zohary and Hopf 1993). Wherever date palm is cultivated for fruit, a clear distinction is made between the traditional cultivars called *varieties* and cultivars that derive from a unique descended individual of seed, cloned thereafter by vegetative multiplication of offshoots.

Currently, cultivation techniques and the processing industry of dates in Libya are underdeveloped in the modern sense; consequently, date fruit production is quite low and entirely consumed locally. This chapter analyzes all aspects of the date palm status, starting from the past to the present day and provides the results of a cooperation program between Italy and Libya to improve and promote date palm cultivation and fruit production in Libya.

7.1.1 Historical Aspect of Date Palm Cultivation in Libya

Since ancient times, date palm cultivation has been widely practiced in Libya and has had a significant role in the livelihoods of the desert and semidesert areas. Early indications of date growing are known from the fifth century BC as reported by Herodotus who writes that the palms of Awjilah Gialo "proceeding westward, I meet the Nasamones who leave their cattle on the coast during the summer and go up the country to a place in the desert called Augila."

At that time the coastal areas of Libya enjoyed a much more favorable climate than at present. Pliny the Elder (77 AD) reports information gathered by the Roman military expedition in the Sahara led by Cornelius Balbus in the Fezzan and further south in Hoggar, Tassili, and confirms the information of Herodotus, indicating the existence of (date) palm trees in these areas to protect the desert.

The introduction and enhancement of the palms in Libya has benefited by cultivation and irrigation techniques of Egypt where date palm cultivation was developed earlier; many Libyan cultivars, in fact, can be considered of Egyptian origin. Favorable conditions existed for date growing in Libya; Scarin (1938), an Italian observer traveling in Western Libya, stated that *the basin has inexhaustible aquifers, at various depths*.

This kind of bold confidence would be misplaced today. Sokna, in southwestern Libya, still has the best water reserves, although the water table has dropped from 3–5 m to 150–200 m, while for more than 20 years, Waddan has been drawing on nonrenewable fossil water from depths of 1,500–2,200 m. This sulfurous water flows out of the ground at a temperature of over 70 °C and under very high pressure. It is allowed to cool in reservoirs before being mixed with fresher water and pumped to the fields for agricultural irrigation.

Historical photographs from the IAO (Istituto Agronomico per l'Oltremare) photograph archive representing date palm groves in the 1930s are shown in Figs. 7.1, 7.2, and 7.3.

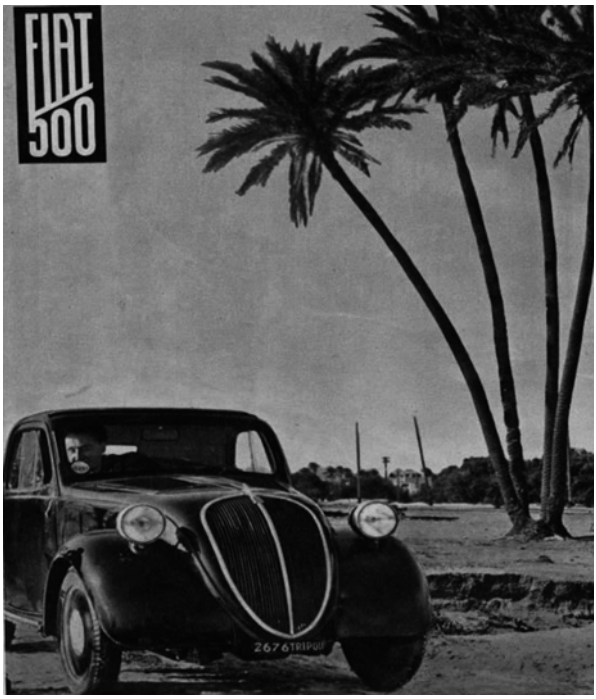

Fig. 7.1 Libya, 1938. Old advertisement using an oasis background (IAO historical photograph archive)

Fig. 7.2 Libya – 1924. Farmers going to the market (IAO historical photograph archive)

Fig. 7.3 Libya – 1938. Date palm cultivation (IAO historical photograph archive)

7.1.2 Geographical Distribution of Date Palm in Libya

7.1.2.1 Coastal Area

Along the Libyan coast, north of parallel 32° N, the best date palm groves are found in the areas of Tripoli, Janzur of Zuara, Homs, Zliten, Misurata, and Tawurgha and Hisha (Fig. 7.4), where there is an abundance of water and reasonably good cultivation practices are followed. Date palm groves are also present to the north of Benghazi. Away from the coast, date palms are only sporadic and occur in the vicinity of wells or springs. Only a very limited percentage of the date palm trees can be considered productive.

For practical purposes, and to the contrary of the cultivation of the Saharan oases, it should be noted that because of the influence of marine moisture combined with lower temperatures, dates produced along the coast are of poor quality, have a high moisture content, and are not very sugary; they are consumed quickly and exclusively as fresh fruit. The main cultivars are Bukerary, Taboni, Lamsy, Blonde, Halaway, Bronzi, and Baudi.

7.1.2.2 Central Area

Located between 30° and 27° N lat., the Central Intermediate Zone includes oases of predesertic areas that run along the 29th parallel north, including Ghadames, Sokna, Hun, Waddan, Zellah, Al Fugha, Maradah, Jalo, Awjilah, and Giarabub (Fig. 7.4), where the best cultivars are grown. This area represents the most favorable climatic conditions for date palms in Libya.

Fig. 7.4 The date palm productive areas in Libya (*shaded areas*)

The climatic conditions are represented by thermal units (°C/day) fluctuating between 1,944 ± 124 of Jalo and 1,569 ± 138 of Al Jufrah, by a relative humidity of 40–50 %, and a low rainfall of 10 mm during the period from August to October. The main cultivars in this area are Abel, Bestian, Deglet, Halima, Hamria, Kathari, Tagiat, and Saiedi.

7.1.2.3 Southern Area

South of the 27° N parallel, in the southern part of Libya, there are a series of Saharan oases which include Fezzan, Ghat, Sabha, Murzuk, Kufra, and Tazerbo (Fig. 7.4), where date palm cultivation has a different development in terms of production and quality.

The dates of these oases have a very high sugar content, which is usually above 70 %, and only rather limited moisture content; therefore, they are suitable for

long-term storage, providing they are protected against insects and are well packaged. The dates of this third area are mainly of the dry type. The main cultivars are represented by Amjog, Emeli, Awarig, Tascube, Intalia, and Idaw.

7.1.3 Water Status in the Desert of Central Libya

The Al Jufrah region lies to the north of central Libya, around 200 km from Sirte on the coast. Al Jufrah oasis constitutes three adjacent oases (Sokna, Hun and Waddan) within a radius of aprox. 40 km and two smaller oases (Al Fugha and Zellah) approx. 200 km southeast and southwest, respectively, from the main nucleus. The presence of significant water resources and loose soil in the region has allowed the growth of different groups of date palm trees.

The large Al Jufrah basin (from the Arabic *jof*, meaning belly or hollow) stretches from west to east and is bordered to the south by the spurs of the volcanic Jebel Soda and the basaltic Black Mountains; to the northwest by the eroded slopes of the Jebel Machrigh; to the northeast by the Jebel Waddan, the Waddan Mountains; and to the east by the Harugi Mountains. The desert landscape is much more than just dunes and sand. Here it is a vast flat expanse of gravel (*serir*) or quite large pebbles (*hammada*), interrupted by hills shaped like truncated cones, smoothed by millions of years of erosion since their formation. The land is furrowed by *wadis*, riverbeds now permanently dry but once able to fill with water in just a few moments, becoming dangerous when sudden, heavy rains would cause flash flooding.

From above, the network of *wadis* looks like a maze of lines intersecting the whole landscape, their course easily traced by the vegetation concentrated along them, mostly made up of tamarisk and African acacia. Tree roots extend deep into the ground in search of water, and their leaves have become spines to limit moisture loss and for protection against animals desperate to feed on their greenery. The acacias are so hardy that on average they live for 200 years. The average elevation of Al Jufrah is around 220 m, but there is some difference (around 60 m) between the area of Sokna and the eastern part of the plateau, caused by ancient movements of the earth's plates. Springs flow around Sokna and feed the rest of the region, making it the most precious water reservoir in Al Jufrah.

The abundance of water just a few meters below the surface has permitted the cultivation of date palm trees, which in the past were rarely irrigated. There were 80,000–88,000 palms in Al Jufrah in the 1930s. Sadly, the Sokna plantations, probably the largest with around 35,000 trees, were partially destroyed during the constant clashes between Arabs and Berbers, who had one of their strongholds here. In fact the story of Al Jufrah has always been marked by the ongoing conflict between various ethnic groups with raids by nomads on more settled peoples, possessors of the region's only wealth: date palm groves and vegetable gardens.

Wild date palm groves, growing without human intervention, draw out water with their roots and still survive today, after hundreds of years. Whereas, the selected cultivars of date palms intentionally planted in groves are irrigated so that they fruit

more abundantly and produce softer, more succulent fruits. While production from an irrigated tree can reach up to 80–100 kg, a nonirrigated palm produces on average 15–20 kg of fruit. The palms can be irrigated using the tradition system, through a network of channels made of soil surrounding every plant, or with modern drip irrigation, which uses much less water. The drip technique strategy can be used during the tree's initial growth.

The local people recall that up until the 1960s, the slopes of Jebel Soda were green with vegetation and, like the entire surrounding area, would become covered with grass as soon as it rained, allowing inhabitants of the nearby villages to raise animals other than camels. Today, however, the landscape has dried up, and 1952 remains imprinted in local memory. That year the peasants of Sokna rushed to the slopes of the Black Mountains after the extraordinarily abundant rains allowed them to plant even wheat and barley. In the new millennium, rains of a short period of time now come only every 3–7 years.

7.2 Cultivation Practices

Presented here are the best practices identified and shared with technical partners and date palm producers in the central area of Libya, during the realization of the program: Improvement and Valorization of Date Palm in Al Jufrah Oasis (Mancini 2010; Slow Food Foundation 2010). Some of the general information in this chapter is drawn from Mancini (2010).

Date palm production takes place in oasis zones whose arable soils are primarily sandy, and therefore highly permeable, and whose agricultural use is strongly influenced by the availability of irrigation. Water is drawn from strata of variable depths through wells and distributed using modern or traditional systems depending on the age of the plantation.

7.2.1 Plantation Establishment

Date palms are propagated through offshoots naturally produced by female and male adult plants. In order to be useful for a new planting, an offshoot must have a weight of 10–15 kg and a base diameter of at least 20–25 cm and no more than 35 cm when removed from the mother plant. Offshoots for propagation are taken between March and May. They are removed from the mother plant, generally after 4–5 years from planting depending on the cultivar, when the tips of the second leaf from the bottom of the offshoot start to dry up.

Offshoot planting in the ground must be performed during the same day in the afternoon or, at the latest, the day after they are removed. During cleaning of the offshoots, it is necessary to remove the external leaves and maintain at least five inner leaves by cutting them in half over the leaflets. Then the leaves are tied together with a leaf rachis.

To encourage root formation without weakening the plant, when the offshoot is planted, the foliage surface must be significantly cut back and covered to limit the action of the sun and water loss by transpiration. During this period it is necessary to keep the soil moist to guarantee absorption from the earliest development of the new root system. After planting, the date palm will be unproductive for around 5 years. The first significant production will only come after at least 8 years, and full productive maturity will be reached after around 20–25 years. Under specialized conditions, new plantations are laid out on a square grid with each plant at a minimum spacing of 6 by 6 m and a maximum of 8 by 8 m.

One month before digging holes for planting the offshoots, it is recommended to lay down the irrigation tubes underground between the rows and to irrigate the planting sites to facilitate the transplanting operations and marking the sites for holes ($1 \times 1 \times 1$ m) in areas with good sandy soil. Where a hard and calcareous underground layer is present, it must be broken up. It is not advisable to place the palms closer than 6 m from each other.

After planting the offshoot in the hole, it is suggested to raise the leaves off the ground to avoid any inward drainage and entrapment of water which could cause rot at the leaf base. The hole should be filled with the previously removed soil (except stones) and compacted around the palm and creating a basin around the trunk (diameter 1.5 m) to prevent water runoff. A male palm should be planted for every 20–25 female palms. Drip irrigation is recommended.

7.2.2 Irrigation and Fertilization

After planting, the soil must be kept constantly wet around the roots for the first 6 weeks, irrigating in the early morning (up to 10 am) and/or in the late afternoon (after 6 pm), providing 100 l/day water per offshoot and 200 l/day for adult palms, from February to October; but only once a week during winter to avoid early flowering.

The use of mechanical equipment to work the soil is very rare. The only soil work involves cutting weeds and repairing the furrows and basins constructed for irrigation (Arara 1975). Weeding is done manually, usually in January and February, before the date palms flower. The soil is fertilized with organic materials. Farms make use of their own manure, preferably well seasoned for at least 6 months, to fertilize the soil where a new palm grove is going to be planted. The use of compost heaps is common (Buys 1993). All plant waste produced by the farm is placed in a ditch, layered with soil and irrigated frequently to encourage the processes of decomposition and mineralization. The compost is then spread around the grove. The amount of fertilizer depends on soil composition and water quality and is best applied during the winter months from December to early March.

Chemical fertilizer such as DAP (diammonium phosphate) or NPK fertilizer (450–500 g/plant) is applied in November around the trunk, while the micronutrient fertilizer LINAFED (200–250 g/plant) is applied in two applications in spring or in early summer with the first application laid down north to south and the second east to west.

7.2.3 Disease and Pest Control

Protection of the date palms does not involve the use of any particular parasitical products, which is partly due to the climactic conditions, which discourage the development of multiple generations of entomophages and the proliferation of fungi (Bitaw and Ben Saad 1990; Edongali 1997; El-Alwani and El-Ammari 2007; Gariani et al. 1994; Martin 1958). During the winter, a natural copper-based antifungal treatment can be applied where necessary. It is possible to use natural parasitoids to organically combat entomophages, which attack the fruit, particularly during the ripening phase.

White scale (*Parlatoria blanchardi*) and mealybug (*Maconellicoccus hirsutus*) are the most dangerous pests of date palm and are effectively controlled with Dursban (150–200 ml/100 l) or Cyperkill 25 EC (150–200 ml/1,000 l) plus mineral oil during winter. The same products can be applied in June to control frond borers and *Ephestia* moths, when fruits start to mature up to 3 weeks before harvest. Damage by white scale is very serious on young palms 2–8 years of age, but even under severe attacks, the palm and its offshoots survive. Nymphs and adults suck the sap from the leaflets, midribs, and dates. Beneath each scale insect, a discolored area is created on the leaflet. Heavy infestation causes leaflets to turn yellow, and respiration and photosynthesis are nearly stopped resulting in early death of the infested leaves. Damage to fruits is easily noticed and makes the fruit unmarketable. The number of insect generations which can develop in 1 year varies from three to four depending on temperature conditions. All chemical treatments must be applied in early morning or late afternoon.

Red palm weevil (*Rhynchophorus ferrugineus*) and bayoud disease, caused by *Fusarium oxysporum* f. sp. *albedinis*, are prevented with quarantine controls on offshoot imports from Egypt, Algeria, or Morocco. From an economic point of view in Libya, damages caused by diseases and pests normally are not serious. This is due to the great biodiversity, the remoteness of the different crops from each other, and the minimal presence of intensive monoculture of cultivars.

7.2.4 Intercropping

The intercropping of alfalfa in date palm plantations has positive effects due to nitrogen fixation, microclimate improvement, and heat reflection/reduction from the soil but has high water requirements. Sowing is realized in early spring or autumn. Other crops like corn, garlic, onion, and other vegetables and cereals such as wheat, barley, and oats can easily be cultivated inside the basin surrounding the tree, which is irrigated regularly. An important benefit of intercropping is that it generates additional income to the farmers, especially in the period before the date palm begins to bear fruit.

7.2.5 Pollination and Fruit Thinning

From the end of February to mid-April, depending on temperature and humidity conditions and the cultivar, it is necessary to carry out artificial pollination, using, if possible, the same male cultivar of the female to be pollinated. The process consists of applying pollen to the female inflorescence by hand or aided by a pole once the flowers start opening. Hand pollination is normally repeated three times and depends on whenever the spathe is open and on the skill of the worker. In large modern farms, a compressor is helpful to better distribute the pollen (Wertheimer 1954).

Generally, fruit thinning is realized in May, leaving eight bunches (two for each cardinal point) per palm, choosing bunches in the middle part of the canopy.

7.2.6 Harvest and Postharvest

Date palm fruits are harvested from August to November (peak period in September/October) depending on cultivar and maturity stage, with manual selection of the best fruits on the stalk (for premium cultivars) or removal of the entire fruit bunch and selection on the ground. Manual fruit selection takes place until mid-September. Harvest timelines of the most important cultivars in the Libyan oases are indicated in Fig. 7.5.

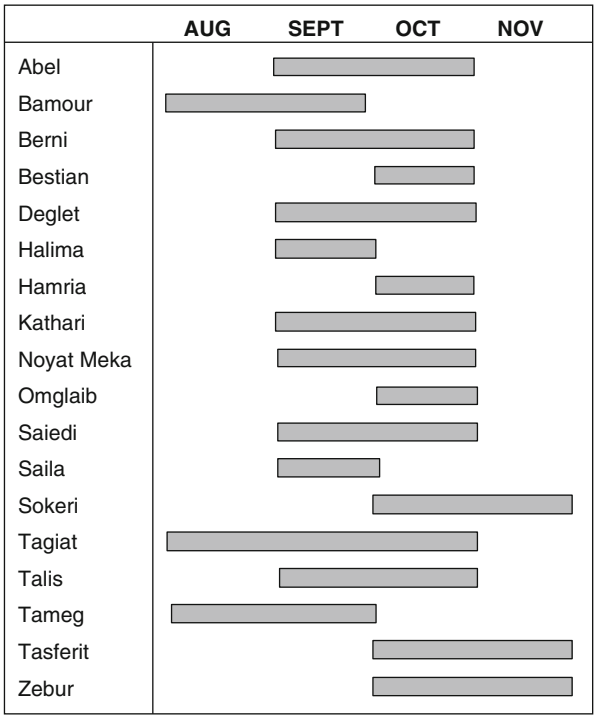

Fig. 7.5 Date palm cultivar harvest timeline in Libyan oases

To climb a date palm tree, which over the years can reach a considerable height, harvesters use the simplest of means: hands and feet. Tough calluses form on the skin after contact with the petiole bases where leaves have been cut from the trunk. Repeated experience shows that the most expert workers can climb even the tallest palms in just a few seconds. Many harvesters use a simple harness made from a strong rope woven from palm fibers, while others use a modern ladder. Some old and very tall palm trees have steps cut into the petiole bases for hand- and footholds, facilitating the climb to the top.

During the first stage of the harvest (September/early October), the harvesters climb each palm several times a week to remove the fruits from bunches as they gradually reach the appropriate ripeness, leaving unripe fruits to continue maturing in the sun. Fruit selection takes place directly on the tree during this first part of the season. In the later part of the harvest stage (end of October), when falling temperatures stop the fruit from ripening further, selection no longer takes place on the tree, but on the ground after the entire fruit bunch is detached and brought down. On the ground, the remaining fruit on the clusters are detached and classified as first, second, or third grades. Rejected fruits are fed to animals or used to produce alcohol in non-Muslim countries. Dates which have not fully ripened on the palm are left in the sun for around a week to mature before being packaged.

The traditional date cultivars of the Al Jufrah oases are primarily sold fresh, and commercialization must follow specific technical procedures to guarantee that the quality and safety of the product is maintained.

Immediately after harvest, it is necessary to wash them in potable water and dry the fruits collected at tamar stage (e.g., cvs. Saiedi, Tagiat, Abel, Bestian, Deglet). They then must undergo a rigorous sorting to remove impurities and/or imperfect fruits and any others unsuitable for sale. The sorting must take place in a hygienic facility to avoid any contamination from pathogens and dirt. Doing such work on the ground is not allowed. After processing, the fruits should be stored at −20 °C.

For direct consumption the dates are packaged in cardboard boxes in layers, ideally no more than three in depth. Packaging also must take place under hygienic conditions. Larger containers can also be prepared for distribution within the domestic catering industry. Packaged dates are kept refrigerated until sold, and a continuous cold chain must be maintained to guarantee refrigeration within the country or for shipment abroad.

The dates can also be dried, either whole or pitted. Drying is done in a hot oven. Also in this case, the fresh product must be kept refrigerated until being processed, to maintain quality and food safety. Pitted dates can also be pressed into a paste, used primarily in the confectionery industry.

7.3 Genetic Resources and Conservation

Some of the best dates in the world originate from Libya, and dozens of different cultivars have been preserved here. This extraordinary heritage is the legacy of centuries of agricultural history, carefully safeguarded by today's farmers to give hope for tomorrow's desert.

Compared to the dates that flood European supermarkets around Christmas, Libyan dates represent a superb celebration of biodiversity, with 95 different cultivars still being grown today. This incredible wealth has served as a highly effective natural defense for Libyan date plantations, which have remained free from pathogen attacks like bayoud disease. Pathogens have already devastated some of the widespread monocultures found in countries like Morocco (Djerbi 1983a, b, 1995).

Libya's date cultivars can be divided into three large groups: the soft fleshy-fruited coastal cultivars, which can be eaten fresh or refrigerated for months (cvs. Bronzi, Taluni, Baudi); the semidry cultivars from the central zone, mostly consumed fresh (cvs. Kathari, Abel, Tagiat); and the dry types from the oases of the south, less succulent and fleshy (cvs. Amjog, Emeli, Awarig, Tascube, Intalia, Tamjog). These latter cultivars are suited for drying and can be stored for up to 10 years, making them highly valued by the caravans that formerly crossed the desert.

Those familiar with the desert can distinguish the different date palm cultivars in various ways: the shape of the palm's foliage, the appearance of the leaves, and the length of the leaf spines and whether bunches of fruit are pendant or more upright. Even a European would immediately be able to see the striking diversity among the fruits when they are laid out next to each other, even before they enjoy the bewildering symphony of flavors on their palate. Kathari dates are greener than the yellowish Sokeri fruit; Tagiats have a tapered shape; the prized Halimas offer an incomparable concentration of pleasure that caresses the mouth without ever becoming cloying.

Libya is rich in sayings and legends associated with dates; one example is the old adage *if you plant Bernis, you'll eat Bernis*, referring to a particularly hardy cultivar able to guarantee food security. The date palm cultivars grown in Libya today are the same as those described by Italians between 1926 and 1930, showing how the impressive local genetic wealth representing in date palms has been wisely maintained and regenerated.

The Libyan government recently launched a major project to encourage, improve, and promote date production, creating new plantings in various desert and semiarid regions of the country, expanding research institutions in the sector, and supporting technical and scientific exchanges, with the aim of genetically, agriculturally, and biologically improving the crop in the arid regions. Single-cultivar plantations are not only more susceptible to possible parasitic epidemics but also at greater risk in

Fig. 7.6 Some of the main Libyan date cultivars of the central oases and their local use (IAO photograph archive)

the event of unusual weather patterns during certain key stages in the plant's life cycle, such as flowering and fruit setting, creating the possibility of serious production losses. Additionally single-cultivar crops are more vulnerable to market fluctuations dictated by the changing consumer preferences. Dates are also processed for the production of products such as fresh jam and syrup for local use (Fig. 7.6).

In other Maghreb countries, the gradual impoverishment of traditional cultivars, whose renewal and conservation is no longer ensured, has already led to the cultivation of a smaller number of selected cultivars. The complete abandonment of local cultivars of traditional crops such as date palm will inevitably lead to the reduction of genetic variability available to the species, a variability which comes from a long sequence of natural selection and constitutes the primary factor for environmental adaptation.

As in other North African countries, drought, salinity, desertification, and the old and less productive palm groves have created problems for Libyan date growers, but farmers recognize the importance of safeguarding the cultivars common at the local level and today have access to a heritage that is extremely valuable for the country's environmental and economic future. Typical date palm plantations in Libya of the present day are illustrated in Figs. 7.7, 7.8, and 7.9.

Fig. 7.7 Productive date palm plantation in a nonirrigated area in Libya (IAO photograph archive)

Fig. 7.8 New modern date palm plantation in an irrigated area in Libya (IAO photograph archive)

Fig. 7.9 A productive date palm plantation in an irrigated area in Libya (IAO photograph archive)

7.4 Plant Tissue Culture

At present in Libya, date palm propagation is by offshoots or seeds. Tissue culture, however, offers considerable advantages by comparison. It is important to initiate relevant research in Libya and adopt tissue culture for the following reasons:

(a) Propagation of healthy elite female cultivars (disease and pest-free).
(b) Large-scale multiplication of elite cultivars.
(c) No seasonal effect on plants because they can be multiplied under controlled conditions in the laboratory throughout the year.
(d) Production of genetically uniform plants.
(e) Clones can be propagated from elite cultivars already in existence or from the F1 hybrids of previous selections and seed-only originated palms.
(f) Insure an easy and fast exchange of plant material between different regions of the country or between countries without any risk of the spread of diseases and pests.
(g) Economically reliable when large production is required.

7.5 Cultivar Description

The morphological and pomological traits of the most important Libyan cultivars were recorded based on passport descriptors adopted by the International Plant Genetic Resources Institute, to establish international standards to facilitate germplasm information exchange (Alercia et al. 2001). Table 7.1 lists 18 important date palm cultivars grown in Libya and their main characteristics; Fig. 7.10 provides illustrations of them. Table 7.2 gives the nutritional composition of fruits of six cultivars which have been analyzed.

Table 7.1 Description of the date palm cultivars grown in Libya

Cultivar	Fruit characters	Pollination and harvest months	Distribution
Abel	Oval fruit, yellow with brown patches, smooth, tough, thick skin, hard flesh with a sweet but astringent flavor. High presence of fibers. Easy to harvest. Consumed at tamar stage	Pollinated in March and harvested in September/October by removal of bunches	Well adapted to Al Jufrah area. Widespread in Sokna, Hun, and Waddan and a limited number in Zellah
Bamour	Oval fruit, honey sometime red with pleated and blistered skin semidry flesh, medium presence of fibers. Consumed in rutab and tamar stages	Pollinated in March and harvested in August to September by selection of dates and by removal of bunches	Rare cultivar. It is only present in Waddan and few in Hun

Table 7.1 (continued)

Cultivar	Fruit characters	Pollination and harvest months	Distribution
Berni	Oval fruit, honey amber with smooth and blistered skin, soft flesh, medium presence of fiber	Pollinated in February/March and harvested in October by removal of bunches	Rare cultivar of Sokna, Hun, and Waddan
Bestian	Oval fruit, honey with corrugated skin, altered skin color, semidry flesh, low sugar content, (most recommended for diabetes suffers), medium presence of fibers. Good for postharvest processing. Quick aging process. Consumed in tamar stage	Pollinated in February/March and harvested in September/October by selection of dates and removal of bunches	Common cultivar in Waddan, Sokna, and Hun. It's one of the most widespread cultivars in Al Fugha and Zellah
Halima	Oval and subcylindrical fruit, amber with semidry flesh; the fruit is larger than average and pleasantly sweet without being cloying. Medium presence of fibers. Consumed in rutab and tamar stages. Considered a rare delicacy	Pollinated in March and harvested in September by selection of dates	Rare cultivar of Sokna, Hun, and Waddan
Hamria	Oval fruit, honey with tattooed corrugated skin, soft and semidry flesh. High presence of fibers. Consumed in rutab and tamar stages	Pollinated in February/March and harvested in October by removal of bunches	Very abundant in Al Jufrah. Particularly in Zellah and Al Fugha
Kathari	Oval fruit, greenish yellow fruit, with tattooed corrugated skin, stubby with a thick hard skin, astringent and soft and semidry flesh, astringent. Though slightly, stays soft throughout the year. High presence of fibers. Consumed in rutab and tamar stages	Pollinated in March and harvested in September/October by selection of dates and by removal of bunches	Well adapted to Al Jufrah area. It is one of the most widespread cultivars in Sokna, Hun, and Waddan. In Arabic Kathari means *green*
Libyan Deglet	Oval and subcylindrical fruit, amber with shiny skin, soft and brownish amber flesh. Mild sweet taste. Medium presence of fibers. Very suitable for long period conservation. Consumed in rutab and tamar stages	Pollinated in February/March and harvested from September/October by selection of dates and later removing the whole bunch	The most valuable date cultivar in Libya. It is one of the most widespread cultivars in Sokna, Hun, and Waddan
Noyat Meka	Ovate fruit, honey and dark brown with smooth skin, semidry flesh, medium presence of fibers. Consumed in rutab and tamar stages	Pollinated in March and harvested September/October by selection of dates	Rare cultivar of Sokna and Hun

(continued)

Table 7.1 (continued)

Cultivar	Fruit characters	Pollination and harvest months	Distribution
Omglaib	Subcylindrical ovate fruit, honey sometimes red with blistered and pleated skin, semidry to soft flesh. High presence of fibers. Consumed in rutab and tamar stages	Pollinated in March and harvested in September/October by removal of bunches	Rare cultivar of Sokna, Hun, and Waddan. In Arabic means "Mother of small Hearth"
Saiedi	Elongated oval fruit, translucent dark brown, with a thin tender skin and soft, syrupy flesh. Easy to harvest. Low presence of fibers. Consumed in rutab and tamar stages	Pollinated in March and harvested in September/October by selection of dates	It is of ancient Egyptian origin but now one of Libya's most important cultivars. Widespread Al Jufrah Oases
Taila	Ovate fruit, honey with corrugated and tattooed skin, soft and semidry flesh, medium presence of fibers. Consumed in rutab stage	Pollinated in February/March and harvested in August/September by removal of bunches	Present only in Sokna and Hun
Sokeri	Ovate subcylindrical fruit, honey with corrugated tattooed skin, semidry flesh, presence of fibers. Consumed in tamar stage	Pollinated in March and harvested from October/November by removal of bunches	Common cultivar in Sokna, also exists in Hun and Waddan
Tagiat	Elongated oval fruit, dark brown with a smooth, thick, hard skin and soft flesh. Early and prolonged harvest period. All the maturity stages of the fruit can be used. The best cultivar to prepare paste, using tamar	Pollinated in February/March and harvested from August/October by removal of bunches	One of the most widespread cultivars in entire locality of Al Jufrah Oases
Talis	Subcylindrical fruit, honey with pleated and corrugated skin, soft and semidry flesh, medium presence of fibers. Consumed in rutab and tamar stages	Pollinated in March and harvested in October by removal of bunches	It is present in Zellah
Tameg	Subcylindrical fruit, honey with pleated and corrugated skin, soft and semidry flesh, medium presence of fibers. Consumed in rutab stage	Pollinated in March and harvested from August/September by selection of dates	Rare cultivar
Tasferit	Subcylindrical fruit, honey dark brown with blistered skin, semidry flesh, and medium presence of fiber. Consumed in tamar stage	Pollinated in March and harvested in October by removal of bunches	Presence in the dry farm plantations of Sokna, Hun, and Waddan
Zebur	Subcylindrical fruit, honey dark brown with pleated blistered skin, soft to semidry flesh, and medium presence of fiber. Consumed in rutab and tamar stages	Pollinated in March and harvested in October by removal of bunches	Rare cultivar

Fig. 7.10 Fruits of various date palm cultivars grown in Libya (Source: (IAO photograph archive))

Table 7.2 Nutritional composition of fruits of six date palm cultivars grown in Libya

	Sugars, %				Ions, mg/kg			
Cultivar	Total sugar	Fructose	Glucose	Sucrose	Mg	*K*	*Z*	Fe
Abel	71.3	35.1	36.0	0.2	594	7,013	3.2	7.6
Bestian	69.8	33.7	36.0	0.1	887	7,752	6.1	11.3
Deglet	69.2	20.3	22.0	26.9	561	7,314	1.7	5.7
Halima	73.4	34.9	38.4	0.1	610	6,010	3.9	7.4
Hamria	73.2	34.2	37.0	2.0	619	7,156	4.3	11.0
Saiedi	65.0	29.6	35.0	0.4	529	6,222	4.6	6.8

7.6 Cultivars Identification Using Molecular Markers

Libya's date palm genetic resources deserve to be evaluated with the aim to organize their preservation, to transmit a significant genetic richness, and also to exploit it. Molecular markers, based on polymorphisms at the DNA level, are currently used and have proved effective to assess genetic diversity. Microsatellites, or simple sequence repeats (SSR), represent a suitable tool for genotyping because of their particular features such as their codominant nature and their typically high levels of allelic diversity at different loci.

In Libya, each palm grove is typified by a distinct cultivar composition, which results from local selection within the oases. Date palms have been mainly clonally propagated by offshoots, in just a few cases seed propagation is performed using the pollen available from male trees of undefined origin. In general each cultivar derives from an individual seed, cloned thereafter by vegetative multiplication to ensure the identity and uniformity of the cultivar. However intra-cultivar variation could potentially cause problems in cultivar identification. The demonstration of the true-to-type character of the plants is an important part of quality assurance, and it requires the use of markers effective in distinguishing the cultivars.

Morphological traits and isoenzyme markers have been used in the past to describe and identify the date palm cultivars of North Africa. Identification of a particular date palm cultivar is principally based on the morphology of leaves, spines, and fruit characters. However, morphological traits are often variable or imprecise indicators of plant genotype, being influenced by environmental conditions or varying with the developmental stage of the plant (Elhoumaizi et al. 2002). Genetic fingerprinting by means of molecular markers of Libyan date palm cultivars has been performed with the aim both to identify the cultivars and to investigate the genetic diversity in Libya to improve production of this crop. For that purpose the parentage analysis of pollinator plants was also attempted to contribute to fruit quality breeding.

Eighteen cultivars, representing common genotypes in Al Jufrah oasis, were selected for their good fruit quality and were analyzed using 16 highly polymorphic microsatellite loci. Plant materials consisted of young leaves of adult trees randomly sampled in the localities of Sokna, Hun, Waddan, Zellah, and Al Fugha. The 18 cultivars are listed in Fig. 7.11, along with the number of female plants sampled in each locality. Dried leaf material was ground into a fine powder and then subjected

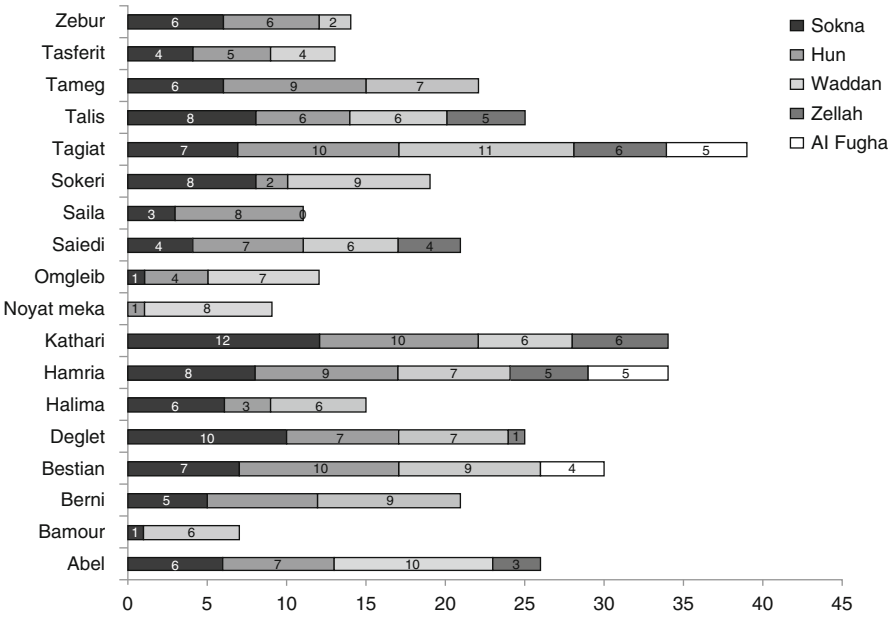

Fig. 7.11 Distribution of cultivar samples among the localities of Al Jufrah oasis, Libya (Modified from Racchi et al. 2013)

to DNA extraction. Sixteen date palm–specific primer pairs were selected for their polymorphic information content among the SSR loci, as developed by Billotte et al. (2004) and Akkak et al. (2009). Amplifications were performed in an Applied Biosystem Thermocycler (AB System, Germany), and PCR products were resolved on a MegaBACE 1000 (GE Healthcare, USA) sequencer (details in Racchi et al. 2013). A large number of SSR alleles were revealed with a mean of 6.88 per locus and allowed to detect a relatively high degree of genetic variability (Table 7.3). A high level of polymorphism was detected among cultivars as previously reported for cultivars in Algeria, Morocco, Tunisian, and Sudan using both isoenzyme and SSR markers (Bennaceur et al. 1991; Elhoumaizi et al. 2006; Elshibli and Korpelainen 2008, 2009; Zehdi et al. 2004a, b).

Each cultivar results from an empirical selection carried out by the farmers in the oases based on morphological characters and fruit quality; this fact justifies the presence at the same time of fixed alleles, 28 out of 110, due to random drift and the high level of heterozygosity due to a clonal breeding procedure for heterosis. Both number and frequencies of alleles vary among the localities due to a different presence of the cultivars in the localities. A good example is represented in Fig. 7.12 by locus mPdCIR10, which exhibits six alleles: the allele 154 is fixed in 9 out of 18 cultivars, while alleles at locus CAT11 are greatly polymorphic in Fig. 7.13. These loci well exemplify the different distribution among the oases; in fact while CAT11 alleles are present in all the oases, some CIR10 alleles are not equally distributed. The mean number of alleles varied from one cultivar to another.

Table 7.3 Microsatellite allelic data revealed by 16 SSR loci in female trees of 18 Libyan date palm cultivars

Locus code	Allelic range (bp)	Total alleles	Number of genotypes	H_{obs}	H_{exp}
PdCIR10	138–176	6	13	0.41	0.46
mPdCIR15	142–157	6	15	0.87	0.77
mPdCIR25	219–257	6	17	0.90	0.76
mPdCIR32	306–321	5	13	0.71	0.66
mPdCIR70	205–227	9	32	0.91	0.83
mPdCIR78	126–173	11	36	0.85	0.85
mPdCIR85	175–199	8	39	0.83	0.85
mPdCIR93	181–197	7	17	0.77	0.77
PDCAT1	103–123	4	10	0.23	0.63
PDCAT2	186–209	7	20	0.85	0.79
PDCAT6	142–172	7	17	0.82	0.71
PDCAT8	222–258	6	14	0.78	0.68
PDCAT11	154–177	6	20	0.75	0.79
PDCAT14	141–163	9	20	0.42	0.63
PDCAT17	131–157	6	14	0.45	0.63
PDCAT18	123–149	8	29	0.88	0.77

Modified from Racchi et al. (2013)
H_{obs} observed heterozygosity, H_{exp} expected heterozygosity at the HW equilibrium

The results, reported in Table 7.4, evidence the different genetic structure of the cultivars. All are characterized by negative values of the fixation index (F) due to an excess of heterozygotes respect to HW equilibrium, though at different level. In particular, cvs. Talis, Halima, Omglaib, Saiedi, Tagiat, Saila, and Zebur present $F=-1$, which indicates a strong heterotic selection at the base of the clonal breeding of these cultivars. On the other hand, an F value close to 0 is expected under random mating, as observed in Sokeri that is traditionally seed propagated.

An UPGMA dendrogram based on codominant genotypic distances of SSR loci is presented in Fig. 7.14. The observed cluster topology evidences the genetic diversity existing among cultivars that allow distinguishing them easily.

Codominant genotypic distances allow estimating the average similarity internal to each cultivar ranging from 0 to 20.98. Talis, Halima, Omglaib, Saiedi, Tagiat, Saila, and Zebur cvs. showed value 0, indicating no genetic difference within cultivar in agreement with the fixation index reported in Table 7.5. This result gives evidence that farmers have good skills, based on a long tradition, in clonal propagation. Nevertheless cases of misclassification can occur during propagation because of the difficulty to identify, in some cases, certain cultivars on the base of morphology. On the contrary, the high value (20.98) shown by cv. Sokeri indicating a high level of diversity among the palms relates to the practice of seed propagation of this cultivar.

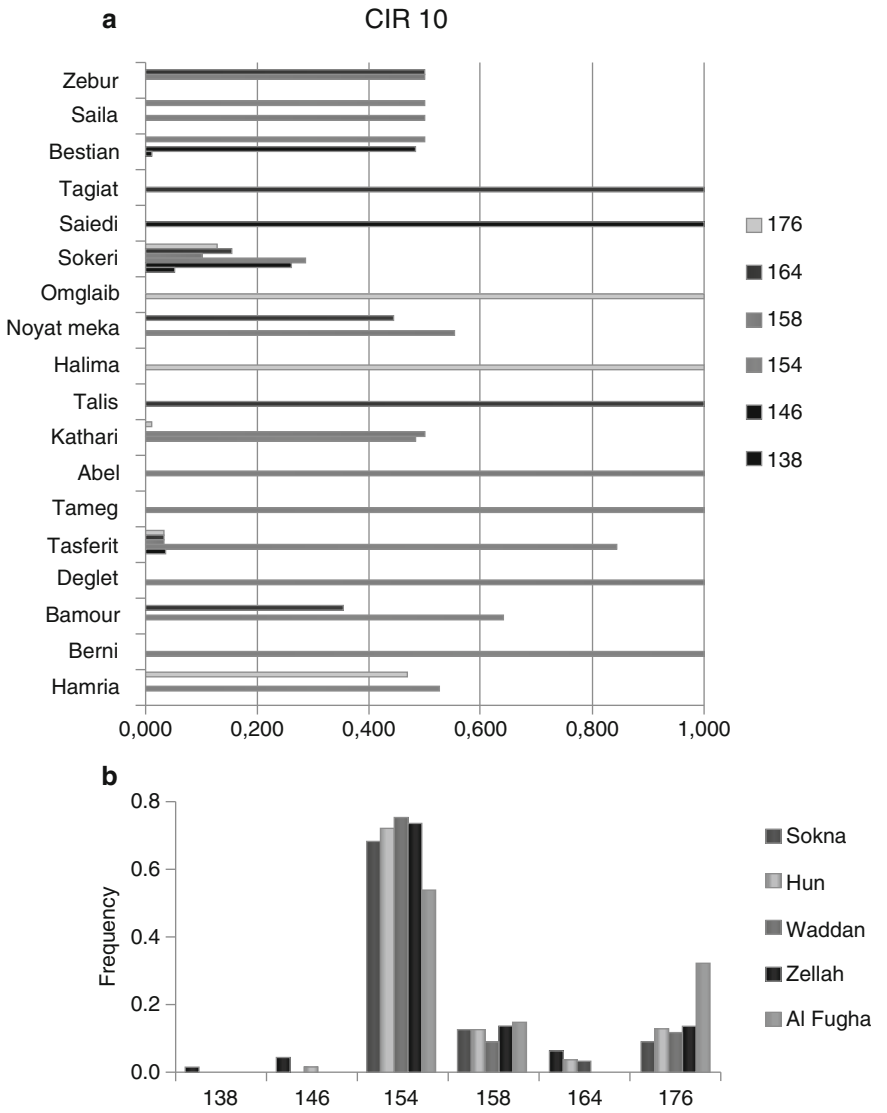

Fig. 7.12 Frequency distribution of alleles of CIR10 marker that varies both among (**a**) cultivars and (**b**) oases

An identification key (Fig. 7.15) was built using three microsatellite loci (mPdCIR78, mPdCIR93, mPdCIR25) and considering the 23 identified alleles: 10 alleles labeled (a1 to a11) for mPdCIR78 locus, 7 alleles (b1 to b7) for mPdCIR93 locus, and 6 alleles (c1 to c6) for mPdCIR25 locus.

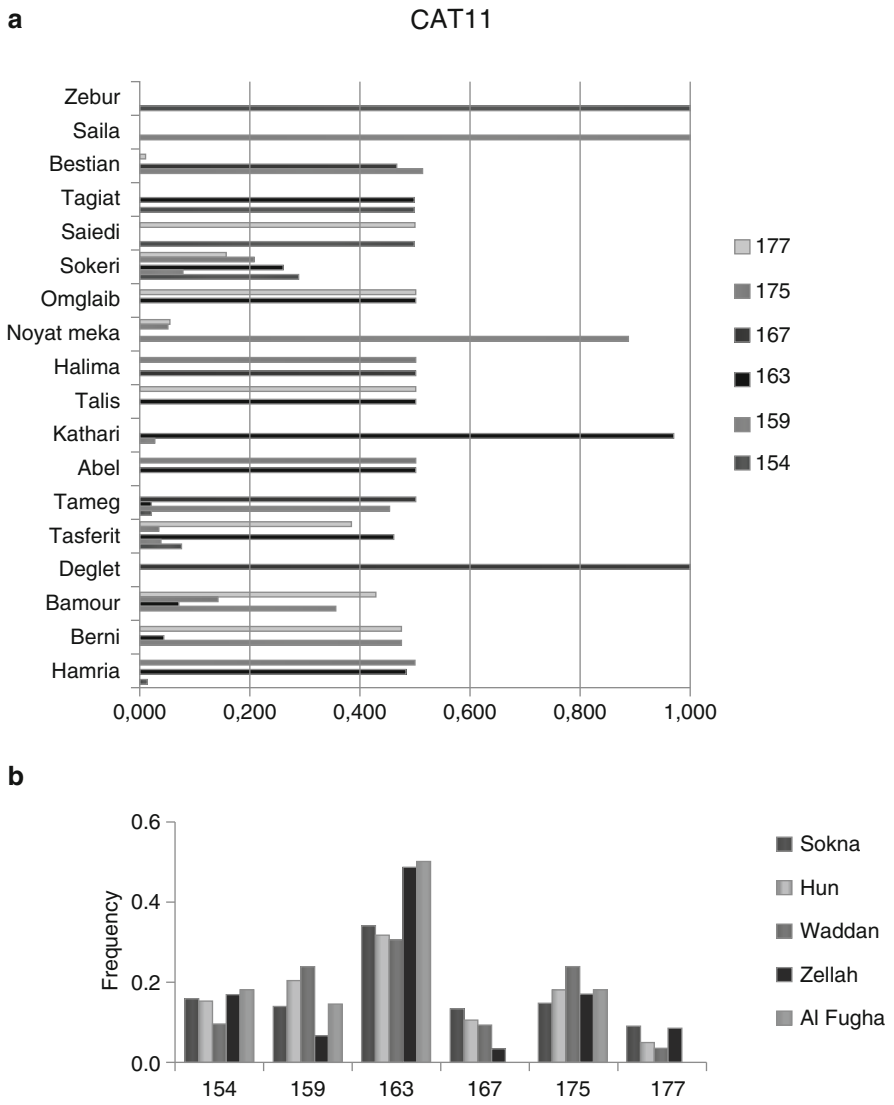

Fig. 7.13 Frequency distribution of alleles of CAT11 marker that varies both among (**a**) cultivars and (**b**) oases

The totality of local cultivars was univocally and easily identified on the base of their allelic profile. Similar result was previously obtained by Zehdi et al. (2006) in an analysis of 49 Tunisian accessions with three SSR loci.

Table 7.4 Genetic diversity indices for 18 Libyan date palm cultivars

Cultivar	*N*	Na	H_{obs}	H_{exp}	*F*
Abel	24	2.875	0.742	0.411	–0.553
Bamour	7	2.813	0.653	0.491	–0.268
Berni	21	2.625	0.622	0.348	–0.567
Bestian	33	2.750	0.629	0.339	–0.557
Deglet	25	1.688	0.625	0.314	–0.993
Halima	15	1.750	0.750	0.375	–1.000
Hamria	34	3.313	0.915	0.497	–0.799
Kathari	34	2.500	0.807	0.425	–0.747
Noyat Meka	9	2.563	0.576	0.365	–0.368
Omglaib	12	1.563	0.563	0.281	–1.000
Saiedi	21	1.813	0.813	0.406	–1.000
Saila	11	1.625	0.625	0.313	–1.000
Sokeri	19	5.125	0.708	0.656	–0.007
Tagiat	39	1.813	0.813	0.406	–1.000
Talis	25	1.625	0.625	0.313	–1.000
Tameg	22	2.750	0.685	0.380	–0.670
Tasferit	12	3.250	0.630	0.420	–0.240
Zebur	14	1.625	0.625	0.313	–1.000

Modified from Racchi et al. (2013)
N sample size, *Na* number of alleles, H_{obs} observed heterozygosity, H_{exp} expected heterozygosity at the HW equilibrium, *F* fixation index

The effectiveness of SSR in discriminating among all the accessions and cultivars examined confirms the usefulness of these markers for clonal fingerprinting and cultivar identification. Since each cultivar was identified by a unique profile, it is possible to generate an individual barcode using the multilocus genotype useful in the certification and the control of origin labels of date palm products.

Considering the SSR effectiveness in fingerprinting genotypes, we used them to assign male plants, sampled in each farm of the different localities within the Al Jufrah oasis. The method of maximum likelihood paternity assignment allowed assigning males to a single cultivar: 55 out of the 63 male plants were assigned to cultivars with strict confidence. The identification key applied to the 24 male plants presenting positive LOD score evidenced that each of them has at least one allele in common with the cultivar assigned by the parentage analysis (Table 7.5). The positive result obtained in identifying male trees further confirmed the suitability of SSR for genotyping and opens new prospects for date palm breeding. More detailed information about DNA extraction, amplification, and genotyping is reported in Racchi et al. (2013).

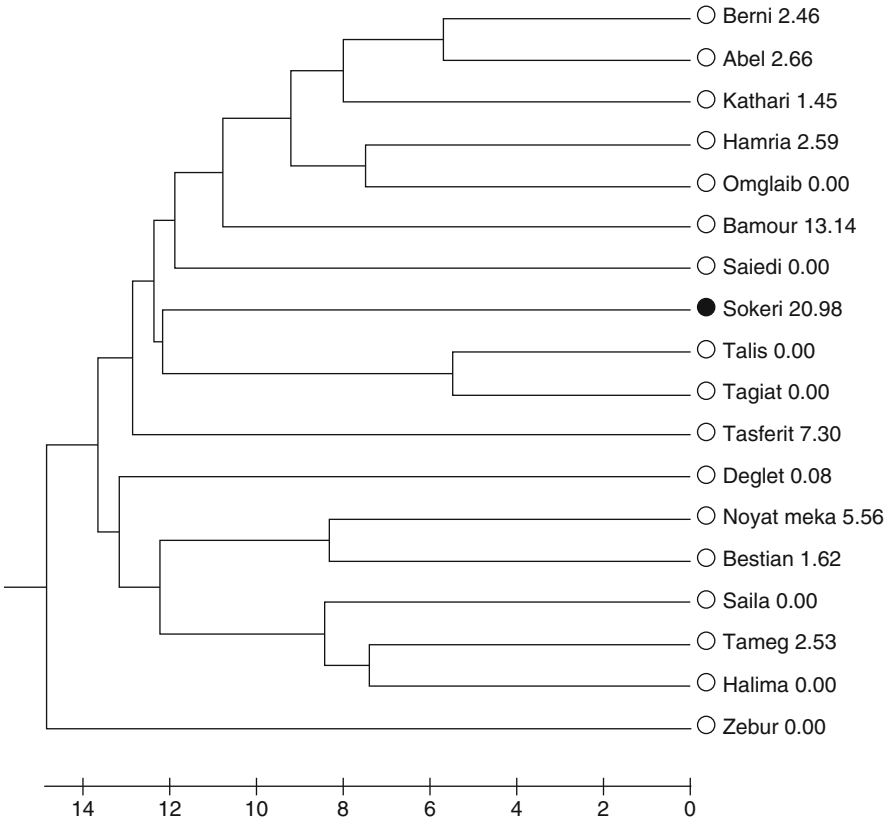

Fig. 7.14 UPGMA dendrogram based on codominant genotypic distances of SSR loci

The observed heterozygosity (H_{obs}) was calculated as the ratio of the number of heterozygotes and the number of samples, for each locus, and as an arithmetic average over loci. The expected heterozygosity (H_{exp}) assuming Hardy–Weinberg equilibrium was estimated as the difference from 1 of the sum of the squared frequency of the each allele. The statistic was computed for single locus and as average over loci. The fixation index or inbreeding coefficient (F) was computed as difference between H_{exp} and H_{obs} divided by H_{exp}.

The calculation of individual by individual genetic distance (GD) for SSR followed the method explained in Smouse and Peakall (1999). Genetic distance matrices for each locus were summed across loci under the assumption of independence. The matrix of distances among cultivars is obtained as an average of the individual distances between couples of cultivars, while the element of the main diagonal is the

Table 7.5 Assignments with positive scores of pair LOD value of parentage analysis performed on male plants sampled in Al Jufrah, Libya

Male ID	Candidate cultivar	Pair loci compared	Pair loci mismatching	Pair LOD score
SMM-Q-04	Kathari	15	0	9.47
SME-Q-03	Tasferit	16	0	0.13
SMT-Q-01	Tasferit	16	2	6.60
SMT-Q-02	Sokeri	15	1	1.26
SSA-Q-01	Deglet	15	1	9.87
SSA-Q-02	Deglet	16	2	1.77
SAK-Q-02	Bestian	16	1	6.97
SAK-Q-03	Sokeri	16	1	2.20
HSM-Q-02	Bestian	16	1	1.26
HRG-Q-01	Tagiat	16	1	3.08
H6I-Q-02	Deglet	16	2	1.05
H6I-Q-03	Tagiat	16	1	5.73
H6E-Q-03	Bamour	16	2	1.33
H3F-Q-03	Tameg	16	1	1.26
H5H-Q-02	Abel	16	1	3.45
H5H-Q-03	Hamria	16	2	2.16
H3H-Q-02	Bestian	16	1	1.12
WOE-Q-02	Abel	16	0	9.15
WBH-Q-01	Abel	16	1	3.33
WBH-Q-02	Sokeri	16	2	1.75
WFZ-Q-03	Tagiat	16	1	9.90
WHS-Q-01	Tagiat	16	1	3.80
W4B-Q-03	Hamria	16	1	1.82
WBB-B	Tasferit	16	0	1.60

Modified from Racchi et al. (2013)

average dissimilarities for all pair-wise comparisons internal to each cultivar. Male trees were assigned to cultivars by a maximum likelihood paternity assignment procedure through comparing genotypes of males and cultivars. To find the significant values of LOD scores, simulations were performed with 10,000 repeats, 0.01 as the proportion of loci mistyped and 61 individual profiles as probable cultivar candidate for each male tree. We used 95 % as strict and 80 % as relaxed confidence level. The LOD score is obtained taking the natural log (log to base e) of the overall likelihood ratio. Genetic variability measures and distance metrics were analyzed using GenAlEx 6.5 (Genetic Analysis in Excel; Peakall 2006; Peakall and Smouse 2012). Cluster analysis was performed using software MEGA version 5 (Koichiro et al. 2011); Cervus 3.0 (Kalinowski et al. 2007) was used for parentage analysis.

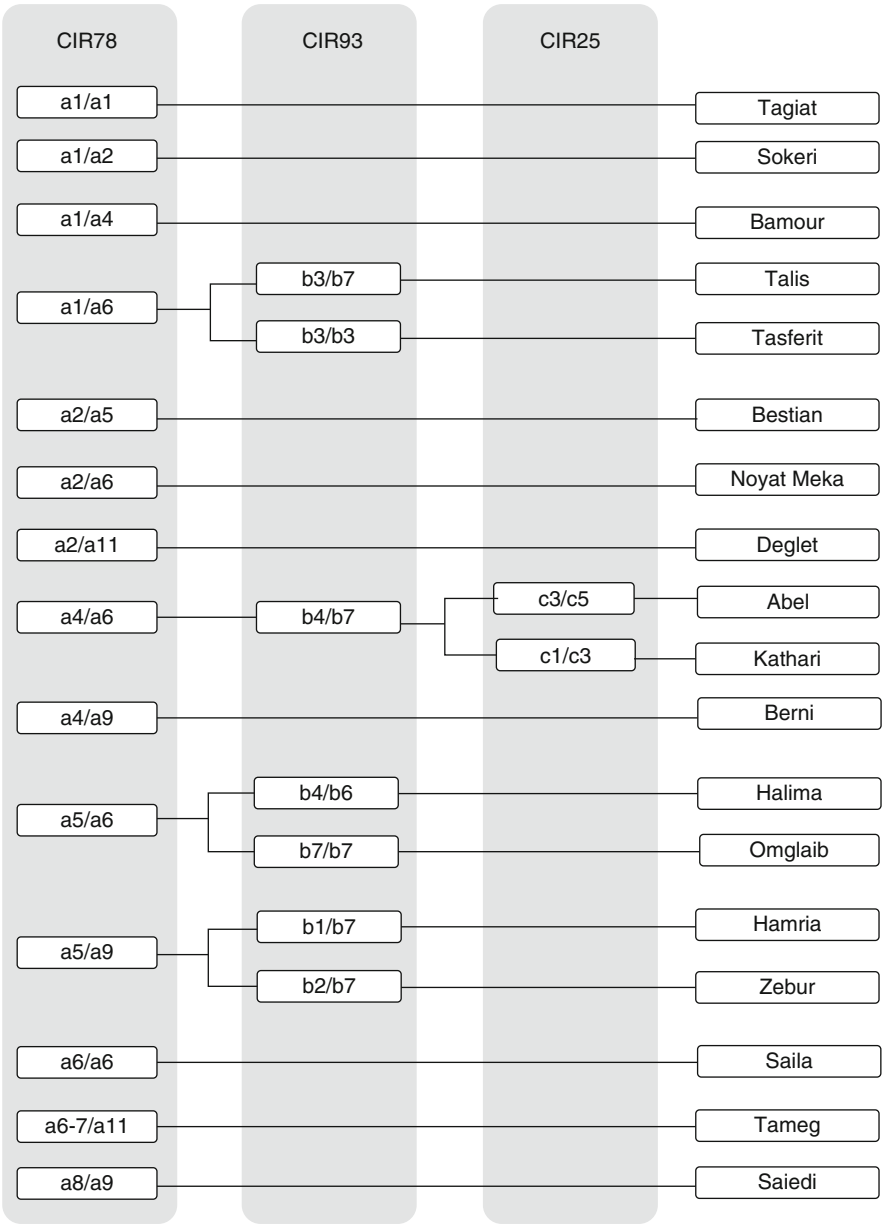

Fig. 7.15 Identification key of date palm cultivars based on 3 microsatellite loci (Modified from Racchi et al. 2013)

7.7 Date Production and Marketing

The date palm is a species with multiple uses (e.g., food, fodder, fuel, plaiting materials, construction) and adaptable to extreme environmental conditions. It has found wide use over the centuries in agroforestry-pastoral xerothermophilous regions, in oases along wadis, and in an environment where one can practice minimal irrigation, even with highly saline water (Dowson 1961; Dowson and Pansiot 1965).

In fact, the cultivation of date palms in Libya presents a very particular situation. The closure of the country because of well-known political events from the 1970s onward, impaired economic development and consequently the commercial development in the international markets of date palms, which represented in the other Maghreb countries the main factor responsible for the cultivar changes and for setting up new plantations (Glasner 1996). The internal market in Libya, in fact, less demanding and poorer than the European market, has allowed for maintenance of the cultivation of many local cultivars, whose fruits are also pleasingly consumed fresh.

The present level of date production in Libya is quite low. All production is consumed locally, and the cultivation techniques and the processing industry are not developed in the modern sense. Nevertheless, the domestic production of dates has increased significantly over the last 25 years concomitantly with the expansion of the cultivated area in dates. This has taken place mainly because of the Libyan government, which in recent years made significant investments in cultivation (FAOSTAT 2013). From 1994 to 2011, date production in Libya doubled, bringing the national production to more than 166,000 mt from about eight million trees. If on the one hand the general situation of date palm in Libya manifests some deficiencies when compared to the other North African countries producing dates in the Mediterranean areas, on the other hand, Libya, more than its neighbors, is a repository of high biodiversity, and it is still free from plant diseases and pests from outside. For this reason Libyan date palm germplasm represents a heritage of great interest both for agriculture and the environment. It is a source of genetic variability useful for genetic improvement, which is necessary to overcome current production limitations.

The cultivar component also significantly contributes to the quality characteristics of date production, based on local cultivars with a strong regional identity and high nutritional value. These characters of naturalness and authenticity make the Libyan dates potentially very attractive due to both the specific organoleptic characteristics and the potential for genetic improvement of cultivars which includes resistance to plant pathogens, adaptability to extreme environmental conditions, increase in production, and improvement of systems of conservation.

7.8 Processing and Products

Until a few decades ago, the date palm stem, cut into linear sections, was used to make support beams, doors, windows, and stairs in houses, while the woven branches, covered in lime, were used for roofing. The leaves and branches were also used to make fences to divide agricultural properties. A *zeriba* is a shelter built from palm fronds, where field tools can be stored. Also built out of palm leaves is the *cecabart*, a clever circular hut in which the hot air rises in the middle and leaves through a chimney-like opening, making it fresh and airy, rare, and precious in the desert. Still today, skilled craftsmen transform the leaves into mats, containers for storing food, everyday objects, incense, jewelry, hats, belts, and bags. The tough fiber can be woven into rope to make harnesses used by harvesters for support when climbing themselves up the palms. The wood not used for construction feeds the fires used to cook food and heating during the cold desert nights and winters.

The apical top of the palm stem can be tapped to extract a sap called *lagbi*, a thirst-quenching, sweet, and highly nutritious beverage. The cutting operation is very delicate, requiring great care so as not to cut into and injure the heart of the tree and kill it. In the past the *lagbi* was collected in a colocynth, a round gourd, typical of the desert which makes an excellent container when dried.

Date fruits are an essential staple food for both humans and animals. Following the way of thinking typical of rural zones, or anywhere with limited resources where nothing is thrown away, the date pits (and today the third-grade dates) are used to feed camels and goats, which give their milk an intense aroma. In Central and South Libya, date fruits are eaten fresh during the harvest season or pressed and mixed with other lesser ingredients to be conserved for leaner months. Dates have always been central to the diet of desert peoples. For the nomads and the animals which carried them across the desert, dried dates were the energy-giving food that could withstand the hottest temperatures (Ali et al. 1956). They were also a precious commodity to be bartered for grains grown along the coast.

7.9 Conclusions and Recommendations

The date palm is recognized for its unique capacity to grow, produce fruit, and accumulate a high quantity of important metabolites under farming conditions with highly restrictive temperatures and aridity. The species adapts well to semidesert conditions. It represents a fundamental economic and food resource in areas that are inhospitable to other plant species, and in fact it can even create a microclimate suitable for other plant species.

Generally, in the Maghreb countries, the gradual impoverishment of traditional cultivars, whose renewal and conservation is no longer ensured, has already led to the growth of selected cultivars. Abandonment of traditional crops will inevitably lead to the reduction of the genetic variability available to the species, a variability which derives from a long natural selection and constitutes the primary factor for environmental adaptation.

Drought, salinity, desertification, and the age of date palm groves have created problems for date palm cultivation, but farmers recognize the importance of safeguarding the cultivars common at the local level and today have access to a heritage that is extremely valuable for the country's environmental and economic future.

Single-cultivar plantings are not only more susceptible to possible parasitic epidemics but also are at greater risk in the event of unusual weather patterns during key stages in the plant's life cycle, such as flowering and fruit setting, creating the possibility of serious production losses. Additionally, single-cultivar production is more exposed to market fluctuations dictated by the changing preferences of consumers. In this context, the Libyan germplasm represents an enormous richness that deserves to be exploited. Its characterization and valorization open new prospects for date palm breeding, protecting the agrobiodiversity by promoting the local palm cultivars and strengthening traditional oasis management systems.

In the past, dates were the ideal staple food for desert crossings, providing energy for nomadic travelers and their animals, helping them withstand the extreme temperatures. Dates were also a precious commodity, bartered for the cereals grown along the coast. Today dates make a perfect breakfast food or a light snack; they are rich in sugars and fibers but have a very low fat content. More importantly, they are very rich in minerals, making them ideal as a source of rapidly available energy in cases of fatigue or physical debilitation.

Acknowledgments This publication represents the results of the international cooperation program for improving and promoting date palm production in Libya *Improvement and Valorization of Date Palm in Al Jufrah Oasis*, funded by the Directorate General for Development Cooperation of the Italian Ministry for Foreign Affairs and coordinated by the Istituto Agronomico per l'Oltremare (IAO) in Florence in collaboration with the Libyan Ministry of Agriculture, Slow Food Foundation for the Biodiversity, and the University of Agriculture, Florence.

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