

Review

Date palm-A gift for health and nutrition: national and international scenario

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ABSTRACT

Date palm (*Phoenix dactylifera* L.), family Arecaceae or Palmae, is cultivated mostly in the arid regions of the world. The crop has played a significant role in the economy of these countries, provides nutritional security, besides helping to mitigate the adverse effects of desertification and climate change over centuries. Date palm personifies human civilization in the arid countries. It is estimated that there are 150 million date palms worldwide, and 75% of these in the Near East and North Africa region. According to the Food and Agriculture Organization (FAO) of the United Nations, the global production of dates has increased from just 1.8 million tons in 1962 to nearly 9.75 million tons in 2022. In India, commercial dates are cultivated mainly in the states of Gujarat and Rajasthan which are emerging as major producers of fresh dates. Besides, local and wild dates are abundant across the country. Dates are consumed fresh or in dry form and considered a complete food, providing food and nutrition security through a wide range of essential nutrients that have beneficial effects on human health. This article presents an overview of dates on nutrition and human health besides giving an insight on propagation, production, protection, processing, marketing, and associated challenges plaguing the sector.

Keywords: Date palm, health, agro-technique, crop protection, value addition

INTRODUCTION

Date palm (*Phoenix dactylifera* L.) is a dioecious species of the palm family Arecaceae or Palmae, predominant in the arid regions of the world and one of the oldest cultivated foods in human civilization, grown in several globally important agricultural heritage sites (FAO). Archaeological evidence suggests that the crop was cultivated 6000 years ago and is currently important to the agrarian economy of many countries (Zohary & Hopf, 2000). In context of the Indian subcontinent, the *Veda* and *Ramayana* period refer to the cultivation of date palm (Shah, 2014). In India, cultivation of the date palm goes back to the fourth century BC (Pareek, 2015). During the early eighth century, the subcontinent witnessed the accidental introduction of Arabian dates by foreign invaders in Western India (Blatter, 1926), which increased with the Arab traders (up to 13th century). Most of the seedling progeny of date palm in India could probably be traced back to this period. The genus *Phoenix* is derived from the ancient Greek bird, while, *dactylifera* originates from the Greek word '*daktulos*', meaning finger.

Date palm thrives in the Near East and North African (NENA) region between 24° to 34° N but is distributed

between 10°-39° N latitude (Johnson et al., 2013). Earlier focus was on selecting superior female palms, propagation through offshoots, crop and water management, segregation by gender, artificial pollination, naming of cultivars and characterization of fruit development stages, texture etc. Of late crop improvement using molecular breeding and tissue-culture for higher productivity and resistance to pests is the focus (Johnson, 2011). Entire genome of cultivar '*Khalas*' has been sequenced (Al-Dous et al., 2011; Al-Mssallem et al., 2013) facilitating incorporation of desirable traits for yield, quality, and stresses (El-Hadrami & Al-Khayri, 2012). Date palm has the ability to withstand severe arid conditions, and salinity up to 2000 ppm.

Area, production and yield

Local populations of the NENA region (Table 1) depend on date palm as a source of income, nutrition and to mitigate the adverse effects of climate change and desertification. In the last three to four decades, the crop is also gaining importance in Australia, India, Indonesia, Mexico, Namibia, Southern Africa, South America, Pakistan, and the United States (Chao & Krueger, 2007).

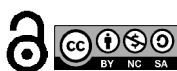


Table 1 : Date producing countries

Continent	Country
Asia (18)	Bahrain, China, India, Indonesia, Iran, Iraq, Israel, Jordan, Kuwait, Oman, Palestine*, Pakistan, Qatar, Saudi Arabia, Syria*, Turkey, UAE and Yemen
Africa (16)	Algeria, Benin*, Chad, Cameroon, Djibouti*, Egypt, Kenya*, Libya, Mauritania, Morocco, Namibia*, Niger, Sudan, Somalia, Swaziland* and Tunisia
America (4)	Colombia*, Mexico*, Peru* and USA
Europe (2)	Albania* and Spain*
Oceania (1)	Australia

Updated from Siddiq & Greibi (2013); *produce <10,000 tonnes/annum

The wide genetic diversity in date palm can be attributed to out breeding (Popenoe, 1992). Worldwide, it is estimated that there are 3000 cultivars though, many are synonyms (Johnson et al., 2013). The original source of most of the present established cultivars in several countries is seedlings, which are raised for breeding, germplasm conservation and for desirable traits (Johnson et al., 2013). Date palm is a dioecious plant which is artificially pollinated for enhancing yield. Male date palms constitute an important genetic resource and pollination is carried either manually by inserting pollen strands in individual female flowers or mechanically using pollen dusters to ensure fruit set (Al-Wusaibai et al., 2012).

The date fruit is botanically a ‘drupe’ typically characterizing the variety (El-Hadrami & Al-Khayri, 2012; Johnson et al., 2013). The texture, shape, color, and chemical composition of the date fruit exhibit high diversity depending on the genotype, environment, season, and cultural practices. *Hababouk*, *kimri*, *khalal*, *rutab* and *tamar* are the five development stages of the date fruit in Arabic, where moisture levels progressively decrease from 80% at the *kimiri* stage to 20 % at *tamar* stage (Fayadh & Al-Showiman, 1990; Al-Shahib & Marshall, 2002).

In the last five decades, there has been a significant increase in the production and productivity of dates. The global production of dates has increased from mere 1.8 million tons in 1962 to 9.75 million tons in 2022 (FAO). Currently, the crop is cultivated over 1.40 million ha (FAOSTAT, 2019) with ~150 million

date palms worldwide, 75 % which exist in Near East and North Africa region. Nearly 90 per cent (8.14 million tons) of the global date production comes from the top ten date producing countries (Fig. 1). Though, major date producing countries are in the Northern hemisphere, it is also cultivated in the Southern hemisphere in Namibia, Indonesia, and Australia. India is emerging as a major producer of fresh dates, with new plantations in Gujarat and Rajasthan (Pareek, 2015) and to a limited extent in Tamil Nadu and Andhra Pradesh (Shah, 2014). Atul Rajasthan Date Palm Ltd. (ARDP), a public private-cooperative venture has taken up date palm cultivation in Rajasthan in a big way.

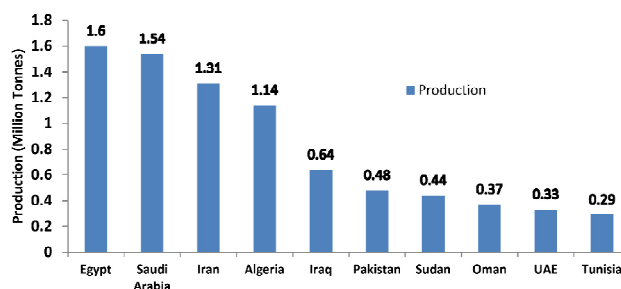


Fig. 1 : Top ten date producing countries (FAOSTAT, 2019)

A 2018-19 report by the Gujarat Horticulture, Agriculture and Farmers Welfare and Co-operative Department reveals that 19,379 ha is under date palm in Gujarat producing 180,255 metric tons of *Khalal* dates. Over 90% of the production is from the Kutch district (Personal communication by Dr. C.M. Muralidharan).

Nutrition and health

Date is called a miracle food and consumed fresh or dry is considered as almost a complete diet. It is a rich source of carbohydrates, dietary fibres, some essential vitamins, and minerals, and a variety of phytochemicals, viz., phenolics, carotenoids, anthocyanins, and flavonoids. Furthermore, date pits (seeds) are also an excellent source of dietary fibre, minerals, lipids, and protein (Ahmed et al., 2013). The medicinal value of dates in terms of therapeutic implications in diseases control through antioxidant, anti-inflammatory, anti-tumour, and ant-diabetic effect are summarized (Rahmani et al., 2014). Date seed extracts have medicinal properties to treat neurodegenerative diseases (Sirisena, et al., 2015; Abdul Afiq et al., 2013). Date fibres have high antioxidant

and antimicrobial activities due to associated lignin and tannins (Shafiei et al., 2010). In general dates have several medicinal properties (Vayalil, 2002; Al-Farsi et al., 2005; El-Hadrami and Al-Khayri, 2012) and are known to;

- Promote digestion and bowel movement
- Boost heart health
- Facilitate healthy pregnancy and childbirth
- Reduce blood pressure
- Provide instant source of energy
- Anti-inflammatory properties
- Promote healthy nervous system
- Strengthen bones
- Help maintain body weight

Dates have a low glycaemic index as date fruit is high in fructose and low in glucose and sucrose making dates suitable for consumption by diabetic patients. Dates are a good source of calcium which contributes to bone strength and rich in iron which is beneficial to pregnant women and anaemic patients. Kurdi et al. (2017) reported that consumption of dates during late pregnancy facilitates easy labour. Dates being rich in oxytocin help to accelerate milk production and therefore recommended for consumption by lactating mothers. Consumption of dates is known to control blood cholesterol levels there by contributing to heart health. The high fibre content in dates plays an important role in digestion and regulation of bowel movement. Dates are low in fat and protein, but rich in healthy sugars, dietary fibre, and minerals (Al-Farsi et al., 2005). Al-Shahib & Marshall (2003) reported that dates including date seeds contain carbohydrates, fat, minerals, protein, vitamins, and a high percentage of dietary fibre and several minerals (boron, calcium, cobalt, copper, fluorine, iron, magnesium, manganese, potassium, phosphorous, sodium and zinc) with significant levels of potassium. Dates are a source of fluorine that is useful in protecting against teeth decay. Cancer fighting properties due to the presence of selenium in dates is another important dietary attribute (Al-Farsi et al., 2005; Al-Shahib & Marshall, 2003; Sirisena et al., 2015). Al-Shahib & Marshall (2003) also reported that dates contain at least six vitamins including a small amount of vitamin C, and vitamins B1 (thiamine), B2 (riboflavin), nicotinic acid (niacin) and vitamin A. Consumption of male flowers and spathe is reported to have invigorating properties

(Popenoe, 1973). Furthermore, Bahmanpour et al. (2006) reported that dates can help in the treatment of male infertility. These nutritional attributes make dates a complete food providing the essential nutrition security especially to the rural communities living in the arid regions of the world where the crop is cultivated since long. Dates are a holistic food that are light and can be easily preserved, and ideally suited for consumption on long distance travel. In providing nutritional security, dates could have a major role to play in the mid-day meal programme for school children in India as well as being a source of instant energy boosting food for the armed forces in the border regions. Date as holistic food, which can be included the National Nutrition Mission of Govt. of India under the 'Poshan Abhiyan' scheme, as it provides instant energy.

Climate and soil

Date palm withstands significant fluctuations in temperature, at $<7^{\circ}\text{C}$, vegetative growth stops leading to a resting period and at $<0^{\circ}\text{C}$ for a certain period of time, metabolic disorders set in leading to partial or total leaf damage. While, date palms are sensitive to cold and frost, date fruits need consistent period of high heat from pollination to maturity, which decides the suitability of the variety for a particular region (Sirisena et al., 2015).

Dates are cultivated generally in regions where precipitation is scarce. Rainfall during pollination and maturity is detrimental to productivity and fruit quality. As high relative humidity has significantly impact on incidence of diseases and fruit quality, it may be difficult to produce high quality *Tamar* dates in India where fruit maturity coincides with the monsoon. Further, enhanced in-groove humidity in young date plantations predisposes the palms to attack by red palm weevil (*Rhychophorus ferrugineus*) (Aldryhim & Al-Bukiri, 2003). On the contrary, low relative humidity coupled with increasing summer temperatures and water stress favors the occurrence and development of mites *Oligonychus afrasiaticus* (McGregor) and the stem borer *Jebusea hammerschmidti* Reich (Al-Deeb, 2012; El-Shafie, 2012). Date palm is reported to withstand high velocity wind. Strong winds may, however, uproot newly planted offshoots and therefore under open desert conditions it is recommended to plant wind break trees along the borders. Wind break trees will

also protect *Rutab* and *Tamar* stages of the fruit from dust.

The crop is mostly cultivated in sandy soils but can adapt to heavy clay soils. Date plantations are characterized by saline and alkaline soils which have a high concentration of soluble salts and sodium, respectively. Addition of organic manures to the soil could be useful to facilitate root formation of newly planted date palm offshoots besides enhancing the water holding capacity of the soil and restrict the adverse effects of alkalinity (Zaid & de Wet, 2002a).

Date palm cultivars

Globally, there are nearly 3000 date palm cultivars endemic to a country or region, some popular cultivars in different countries (Siddiq & Greibi, 2013) are presented in Table 2. The popular date palm cultivars of today are known to have originated from seedling progenies (Johnson et al., 2013). In India, the role of State Agricultural Universities and ICAR institutes/ regional stations, especially of the National Bureau of Plant Genetic Resources (NBPGR), Central Institute for Arid Horticulture (CIAH) and Central Arid Zone Research Institute (CAZRI) located in the date palm predominant states of Gujarat and Rajasthan is important to identify, and conserve non-descript seedling cultivars of date palm. Cryo-conservation of pollen as a source of conservation of diversity, marker assisted selection, use of superior genotypes for date sugar and alcohol hold promise. Three to five years old date palm offshoots are currently widely used in modern commercial date plantations as these are true to type with a known genetic makeup. Besides offshoots, tissue cultured palms are also used to establish new commercial plantations.

Agro-techniques

Date palm cultivation needs special attention when it comes to selection of planting material, palm nutrition, irrigation, pollination, and tree and bunch management.

Propagation and planting

Seed propagation is not true to type, and date palm is widely cultivated through offshoots, mainly produced during the early life of the palm (20 years). Zaid & de Wet (2002b) recommend 3-5 year old offshoots that weigh 12-25 kg with a girth of around 25 cm to be preferred and offshoots that originate high on the palm should be avoided. Besides offshoots, tissue cultured

Table 2 : Popular date palm cultivars in different date producing countries*

Country	Cultivars
Algeria	Deglet Nour, Iteema, Thoory
Egypt	Amhat, Hayani, Siwi, Samany, Zoghoul
Morocco	Medjhool
Tunisia	Deglet Nour
Saudi Arabia	Khalas, Sheshi, Reziz, Sukhari, Sugai, Anbarha
UAE	Lolo, Khalas, Bahri
Iran	Estamaran, Shahani, Kabkab, Mazafati
Israel	Medjhool
India	Bahri, Halawi, Khadrawy, Kuneizi, Zahidi
Oman	Zabad, Hilali Omani, Nashukharma, Khalas, Barni
Pakistan	Zaidi, Mobini, Shakri, Khadrawi, Dhakki
Palestine	Medjhool
USA	Medjhool, Deglet Nour, Empress, Zahidi, Khadrawy, Halawy

*updated from Siddiq & Greibi (2013)



Farmers *Khalal* dates collected from elite non-descript seedling progeny (DPRC, Mundra, Kutch, Gujarat, India)



Dates from elite seedling palms in Sudan (Agricultural Research Centre, Merowe, Sudan)



Tissue culture date palm cv. Khalas

palms are also used to establish new commercial plantations and should be transplanted at 4-plus pinnate leaf stage after hardening (Zaid & de Wet, 2002b). Micro-propagated date palms enable farmers to grow verified varieties instead of depending on offshoot selections (Sirisena et al., 2015).

It is recommended to plant date palm offshoots/tissue cultured plantlets on the surface of a pit (hole) of 1 m³ and mixed well with the organic manure and planted in 10 x 10 m (100/ha), 9 x 9 m (123/ha) or 8 x 8 m (156/ha). In areas with high humidity, spacing of 10 x 10 m and for dwarf cultivars 8 x 8 m is recommended (Zaid & de Wet, 2002b).

To avoid stress to the offshoots / plantlets, planting should be carried out in the early morning. The heart of the offshoots / plantlets should be above the soil surface avoiding deep planting in the pit (hole). A basin of about 3 m diameter and 20 to 30 cm deep should be prepared around the palm soon after transplanting to prevent run-off and to ensure sufficient availability of irrigation water. The basin should have a slight downward slope towards the plant to allow the water to reach the root system of the young plant (Zaid & de Wet, 2002b).

The stem does not come in direct contact with the irrigation water in the basin as this is known to pre-dispose the palms to attack by red palm weevil, *R. ferrugineus* (Faleiro & Al-Dawood, 2020). Mulching of the basin around the palm with organics after planting is highly recommended.

Date palm nutritio n

Global averages requirement of N, P and K per yielding date palm is 650 g, 650 g and 870 g of N, P

and K, respectively needs to be applied/date palm/year. Young palms up to four years old are fertilized at 262-525 g N, 138 g P and 540 g K/palm/year (Klein & Zaid, 2002a).

Irrigation

Date palm responds well to irrigation. Although the crop is known to withstand high levels of salinity, it is important that irrigation water is not highly saline, and the crop is not over irrigated (Liebenberg & Zaid, 2002). In Saudi Arabia, lysimeter based studies on the daily water requirement of date palm ranged between 87 and 297 L during January and July, respectively with a daily average of 182 L through the whole year depending mostly on weather and quality of the irrigation water (Dewidar et al., 2015). The response of date palm to trickle irrigation is better in comparison to the basin method (Al-Amoud, 2000).

Pollination in date palm

Date palm is a dioecious crop where male (pollen bearing) and female (fruit bearing) inflorescences are on separate palms (Popenoe, 1992). To ensure good fertilization, overcome disadvantages of dichogamy and reduce the number of male palms, artificial pollination is carried out, where pollen harvested from staminate flowers are used for artificial manual pollination (as traditionally practiced throughout the Middle East) or mechanically using dusters. Pollination in date palm is influenced by several factors viz. pollination time, flowering period of male palm, the type, amount, viability and availability of pollen and receptivity of female flowers (Johnson et al., 2013; Ben Abdallah et al., 2014). A mature male spathe is soft in texture and attains a brown colour before splitting. Immediately after the spathe breaks,



Date palm pollen applicator

the male inflorescence reaches its maturity and male flower clusters must be cut at this stage (Zaid & de Wet, 2002b).

In commercial plantations, the female flowers are usually pollinated by hand cutting the strands of male flowers and inserting them (2-3 strands) between female flower clusters during the first few days of its opening when the female flowers are receptive, which are loosely tied to ensure successful pollination.

FronD Pruning

Date palm cultural practices recommend the pruning of dry fronds and old fruit stalks (Zaid & Klein, 2002b). Fronds that are nearing maturity become dry, lose their photosynthetic efficiency, and must be removed annually by pruning the fronds at the base close to the trunk. With the growing threat of red palm weevil (*R. ferrugineus*) where freshly cut frond bases attached to the trunk emit volatiles that attract gravid female RPW for oviposition, is vital to protect freshly cut frond bases with insecticide immediately after pruning.



Truck mounted platform to perform operations in the crown of date palm

De-thorning

Date spines on the base of the fronds pose a potential hazard and can result in injury to the workers during different operations, particularly during pollination and bunch management. These spines are usually removed from the new growth of fronds in the crown of the palm just before the pollination season to allow easy access to the date spathe as they emerge.

Protecting pollinated female inflorescences and bunch management

Bunch breaking can be prevented by securing (tying) the fruit stalk to the midrib (leaf rachis) of one of the

lower leaves, for support after pollination. This practice of securing the bunches, also makes the bunch easily accessible for subsequent operations *viz.* thinning, bagging and/or pesticide application. Bagging with paper bags of newly pollinated inflorescences protects from low temperatures and enhances fruit set. During the early *Khalal* stage fruit bunches are bagged using plastic mesh (Zaid & de Wet 2002b).

An adult date palm could produce 20 or more fruit bunches. Reducing fruit bunches after fruit set ensures sustained production in subsequent years. The recommended ideal bunch to leaf ratio is 1:10 (Al-Salman et al., 2012). Thinning of fruits can be achieved through bunch removal, removing strands in a bunch or removal of fruits in the strands. Thinning is practiced increasing the fruit size, besides ensuring early ripening. A 25% bunch removal coupled with 25% strand cutting ensured least number of shrivelled dates in the cultivar Gaar (Al-Darwish & Ben Abdallah, 2010). In commercial plantations, bunch covers are commonly used to protect fruits from birds, insect infestation, high humidity, and rain.

Crop Protection

Date palm is attacked by a wide range of pests and diseases (Table 3). The pest complex of date palm has significantly increased to 12 species of insects and mites and 22 species attacking stored dates (El-Shafie, 2012). Insect pest like red palm weevil (RPW) (*Rhynchophorus ferrugineus* Olivier), long horn stem borer (*Jebusea hamerschmidtii* Reich), rhinoceros beetle (*Oryctes* spp.), mites (*Oligonychus afrasiaticus*) (McGregor), dubas bug (*Ommatissus lybicus* de Bergevin) and the lesser date moth (*Batrachedra amydraula*) Meyrick are of key importance in the NENA region. A framework strategy formulated for eradication of RPW at the Rome meeting aims to support national programs to control RPW (FAO, 2019). New fumigation technologies for storage of dates, using modified atmosphere with ethyl formate in liquid CO₂ are gaining importance (Wakil et al., 2015).

Sedra (2018) described the prevalence and management of 12 fungal, two phytoplasmic and three diseases of undetermined causal agents in date palm. Millions of palms have been lost to soil borne Bayoud or *Fusarium* wilt of date palm caused by *Fusarium oxysporum* f. sp. *Albedinis* (Kill. & Maire) in North

Table 3 : Major pests and diseases of date palm*

Pest/Disease	Scientific name
Pests	
Red palm weevil	<i>Rhynchophorus ferrugineus</i> Olivier
Long horn stem borer	<i>Jebusea hamerschmidti</i> Reich
Rhinoceros beetle	<i>Oryctes</i> spp.
Mites	<i>Oligonychus afrasiaticus</i> (McGregor)
Dubas date bug	<i>Ommatissus binotatus lybicus</i> de Berg
Green pit scale	<i>Palmaspis phoenicis</i> Ramachandra Rao
Carob moth	<i>Ectomyelois ceratoniae</i> (Zeller)
Lesser date moth	<i>Batrachedra amydraula</i> (Meyrick)
Termites	<i>Microcerotermes diversus</i> Silvestri
Almond moth	<i>Cadra cautella</i> (Walker)
Diseases	
Bayoud or <i>Fusarium</i> {XE "Bayoud"} or <i>Fusarium</i> wilt	<i>Fusarium oxysporum</i> {XE " <i>Fusarium oxysporum</i> "} f. sp. <i>Albedinis</i> ({XE " <i>Fusarium oxysporum</i> f. sp. <i>albedinis</i> "} Kill. & Maire)
Black scorch	<i>Thielaviopsis</i> (<i>Chalara</i>) <i>paradoxa</i> (Dade)
Diplodia disease	<i>Diplodia phoenicum</i> (Sacc.) Fawc. & Klotz
Leaf spots disease	<i>Cladosporium herbarum</i> , <i>Alternaria alternata</i> , <i>Drechslera australiensis</i> , <i>Pestalotia palmarum</i> Cooke (<i>Pestalotiopsis palmarum</i> (Cooke) Steyaert), <i>Helminthosporium</i> sp. and <i>Thielaviopsis paradoxa</i> (Dade)
Bending head disease	<i>Thielaviopsis paradoxa</i> (De Seynes Hohn)
Heart and trunk rot disease	<i>Fusarium</i> spp., <i>Botryodiplodia theobromae</i> (syn. <i>Lasioidiplodia theobromae</i>), <i>Chalara paradoxa</i> (syn. <i>Thielaviopsis paradoxa</i> Dade), <i>C. Moreau</i> (asexual stage) and <i>Gliocladium</i> spp. <i>Belaat</i> disease <i>Phytophthora</i> spp.
Apical drying of leaves	<i>Alternaria</i> sp. <i>Phoma</i> sp. and <i>Fusarium solani</i>
Graphiola leaf spot or false smut	<i>Graphiola phoenicis</i> (Moug) Poit.
Inflorescence's rot	<i>Mauginiella scaettae</i> Mich. & Sabet

*El-Shafie (2012); Sedra (2018)

Africa. Black scorch, *Thielaviopsis* (*Chalara*) *paradoxa* (Dade), the phytoplasma borne Al-Wijam and diseases of unknown causal agents are also of concern. The role of National Plant Protection Agencies in strengthening pre and post entry quarantine regimes by deploying appropriate phytosanitary measures will go a long way in preventing the spread of pests and diseases in date palm.

El-Saeid & Al-Dosary (2010) indicate a hazardous trend in the date palm cultivation due to the detection of pesticides in date fruits and seeds above the acceptable limits. This is largely due to the over dependence on preventive chemical treatments to deal with the problem of insect pests like red palm weevil.

Harvesting and sorting

Depending on the cultivar and market, dates are harvested in the *Khalal*, *Rutab* and *Tamar* stages. Fruit harvested at *Tamar* stage do not perish if processed well and with modern vacuum packing facilities can be stored and consumed over a long period of time. In the Northern hemisphere, harvesting of *Tamar* dates takes place at the end of summer (early cultivars) in September and ends in the middle of November (late cultivars). In the Southern hemisphere, dates are harvested between February and April. Thus, if date production picks up in the Southern hemisphere in countries like Australia, there is a good potential to meet the off-season import needs of many countries (Sirisena et al., 2015). High quality dates are harvested (handpicked) individually in several pickings, while bulk harvesting is carried out by removing the entire bunch. Ladders and vehicle mounted platforms are used to harvest the bunches carefully. Harvested bunches are transported to the packaging house for sorting, processing, and packing. In India *Khalal* dates are harvested during June and July. To maintain high quality of dates in the market, it is essential to clean and sort the fruit. Harvested dates are initially graded as per size/weight and subsequently sorted to eliminate defects (blemishes, shrivelled fruit, dates with embedded dirt, mould, decay, fruit damaged by insects/mites etc.)

Processing, packaging, and value addition

In general, fruit size, shape, colour, texture, moisture, and skin separation are important criteria to judge fruit quality of dates which must also be without defects. Processing and packing of dates demand maintaining



Securing the fruit on the palm by covering with mesh



Harvested date bunches

high quality standards that meet norms set by Codex Alimentarius Commission and other quality assurance agencies set by the European Union, USDA and date exporting countries of North Africa (Morocco and Tunisia) are also important. Regarding fresh dates in India, sweetness followed by colour, size of the fruit and fruit weight are considered important (DPRC, Mundra, India). Aleid et al. (2012) extended the shelf life of *Khalal* and *Rutab* stages of fresh Khalas dates through modified atmosphere packaging (MAP). Treatment using CO₂ levels of 20% or below demonstrated promising results for firmness and sensory scores even 18 days after treatment, compared with the control cardboard packaging. Also, magnetic freezing (cell alive system or CAS) showed positive results as compared to conventional blast freezing of fresh dates. These findings hold promise for extending the shelf life of fresh dates.

Chocolate coated dates are an ideal after dinner dessert. Date palm sap jaggery, date seed coffee, compressed furniture boards from pulverized date palm fronds and stem are other possibilities. Date palm waste is also very well-suited for the composting while low quality date fruit and date seed is an ideal resource for incorporating into animal feed. Date seed oil is a rich source of antioxidants (Barrevelde, 1993). Fronds and tree stems as raw materials for producing charcoal (Zafar, 2021), use of dates to brew wine goes back to ancient Egypt (Gatley, 2009), and production of ethanol from dates (Zohri & Etnan, 2018). Date palm based handicraft items like traditional baskets, trays, purses, coasters etc., are also made by local artisans in several date palm growing countries.

Palm jaggery from the wild date palm is an important ingredient of the famous traditional sweet (dessert) ‘*Mishti Doi*’ popular in the Indian state of West Bengal. Sap tapped from the inflorescence of wild date palm in India is used in preparation of several alcoholic and non-alcoholic beverages.



Date paste and date syrup

Marketing and export of dates

According to the International Dates Council, Riyadh, Saudi Arabia, the absence of international standards and weak internal and external marketing strategies is adversely impacting the date industry (IDC, 2013). In India, fresh date’s market is growing rapidly with farmers securing a price of Rs. 30-50/kg, while, the consumer pays around Rs. 150/kg of fresh Barhee dates. India is the world’s largest importer of *Tamar* dates. In the high-end premium markets of the US and Europe, there is a good demand for Deglet Nour and Medjool varieties.



Wholesale dates market in Al-Qassim, Saudi Arabia

Challenges impacting the date palm sector

A recent study by the Arab Organization for Agricultural Development (Oihabi & AOAD team, 2018) indicates that several factors impact the advancement and growth of the date palm sector resulting in the low productivity of dates in many countries. The traditional date palm grooves are dense with palms where the trees are old and have by large exceeded the productive age.

CONCLUSION

With the increase in production and consumption of fresh dates in several countries, marketing norms for this niche category of dates needs to be developed and standardized. India is the largest importer of dates and there is a good potential to increase date production to meet the growing internal demand and tapping the export market. However, like other date producing countries the date palm sector in India is facing several challenges (Pareek, 2015). In India, State Agricultural Universities and ICAR institutes/regional stations *viz.*, Central Arid Zone Research Institute, Jodhpur; Central Institute for Arid Horticulture, Bikaner and the National Bureau of Plant Genetic Resources-Regional Station, Jodhpur, located in the states of Gujarat and Rajasthan have an important role to play in strengthening the date palm sector in the country. Besides these two states there is potential to cultivate date palm in other dry and semi-arid agro-climatic pockets of the country prevalent in Tamil Nadu, Andhra Pradesh, and Maharashtra etc.

National date palm programmes worldwide would stand to benefit by establishing regional and international linkages in certain niche areas of the date palm value chain that could be facilitated through

organizations like the FAO of the UN, International Centre for Agricultural Research in the Dry Areas (ICARDA), Arab Organization for Agricultural Development (AOAD), Khalifa International Award for Date Palm and Agricultural Innovation (KIADPAI), International Dates Council (IDC) etc. In general, the date palm sector lacks adequate support of qualified human resource and dedicated research institutions that can address problems associated with the date palm propagation, production, protection, processing and marketing of dates.

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(Received : 04.04.2023; Revised : 19.12.2023; Accepted : 22.12.2023)