



Project on the Development of Sustainable Date Palm
Production Systems in the GCC countries
of the Arabian Peninsula

HARVESTING AND POSTHARVEST HANDLING OF DATES

By
Adel A. Kader and Awad M. Hussein



International Center for Agricultural Research in the Dry Areas

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Headquarters

International Center for Agricultural Research in the Dry Areas (ICARDA)

P.O. Box 5466, Aleppo, Syria

Tel.: ++963-21-2213433, 2225112, 2225012

Fax: ++9632-21-2213490, 2225105, 5744622

E-mail: ICARDA@cgiar.org

Website: <http://www.icarda.org>

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Foreword

Date Palm (*Phoenix dactylifera L.*), one of the oldest fruit trees in the world, is deeply rooted in the economy, history and culture of the Arabian Peninsula which produces around 1.9 million tones or 29% of the global date production on an estimated area of 365 thousand hectares or 33% of global world acreage occupied by date palm. In spite of the very long history of the date palm cultivation in the GCC countries, the research efforts for its development remained insufficient until recently.

Because of its economic, social and ecological importance, the GCC countries ranked date palm as a research priority for further development of crop production and protection, using the best approach that modern science and technology can provide. The GCC countries joined CGIAR in 2003 and ICARDA was designated to manage the date palm project and make use of its technical backstopping to assist the NARS of the participating countries in developing sustainable date palm production systems. The project consists of three inter-related components (Problem solving research, Technology transfer and capacity building) that share two key objectives – to improve the quality and production of date palm and to optimize crop productivity.

The post harvest sector of this important crop suffers from many constraints including:

- High postharvest losses due to fermentation, insect infestation, birds, and mechanical damage because this sector is largely neglected in the region.
- The produced dates do not satisfy International Regulations and Standards necessary for export.
- Lack of trained personnel in this field and lack of knowledge in International Regulations and Standards.
- Date palm plantations and date productions in the GCC countries have dramatically increased in the recent years but the postharvest sector lagged considerably behind.
- There is a need of utilizing the date's surplus and low quality fruits (bulk of the date production) in producing a wide range of ingredients for many foods, pharmaceutical and industrial products.

Because of the ongoing expansion, higher date production is expected in the future and the need for efficient post harvest handling, marketing and processing has to be established to improve the product's quality, to reduce the post harvest losses (quality and quantity) and to provide the food safety for accessing the market by meeting the standards required by the handlers, the processors and the final consumers.

Most of the dates' postharvest constraints can be overcome by the existing technologies and know how but because of the weakness of the extension services in the region, the growers, the handlers and the processors are not aware of their availability. The present bulletin, summarizing *the postharvest technologies and techniques developed for dates handling and processing* was elaborated to fill the gap.



Prof. Aouine Mohamed
Date Palm Specialist
and Project Coordinator

HARVESTING AND POSTHARVEST HANDLING OF DATES

Adel A. Kader¹ and Awad M. Hussein²

¹Department of Plant Sciences,
University of California,
Davis, CA 95616, USA

²Department of Pomology,
College of Agriculture,
University of Alexandria,
Alexandria, Egypt

Introduction

Date Palm (*Phoenix dactylifera* L.) is thought to have originated in Mesopotamia (what is now Iraq) and its cultivation spread to the Arabian Peninsula, North Africa, and the Middle Eastern Countries in ancient times (about 5000 years ago). In 2006, world production of dates was about 7 million tons and the top 10 producing countries were Egypt, Saudi Arabia, Iran, United Arab Emirates, Pakistan, Algeria, Sudan, Oman, Libya, and Tunisia. There are thousands of date palm cultivars, including those with soft, semi-dry, and dry fruits (depending on their water content at harvest when fully-ripe), grown in these countries. Examples of soft date cultivars (> 30% moisture) include Abada, Amhat, Barhee, Bentaisha, Halawy, Hayany, Honey, Khadrawy, and Medjool (Mejhool). Semidry date cultivars (20-30% moisture) include Amry, Dayri, Deglet Noor, Khalasa, Sewy, and Zahidi. Dry date cultivars (<20% moisture) include Badrayah, Bartamoda, Deglet Beida, Horra, Sakoty, and Thoory.

Dates are nutritious, high-energy food, and important part of the diets of people in the Arab countries and are consumed fresh, dried, or in various processed forms. However, losses during harvesting and postharvest handling and marketing are high due to incidence of physical and physiological disorders and pathological diseases and to insect infestation. These losses can be reduced by understanding and implementing the recommendations given in this bulletin.

Maturity Indices

Maturity stages of dates include "Hababouk"(earliest stage of development), "khimri" ("kimri", "jimri") (Figure 1), "khalal" ("balah", "biser") (Figures 2 and 3), "rutab" (Figures 3 and 4), and "tamar" ("tamr") (Figures 5 and 6).



Fig.1. Khimri stage of date development

Color differences among cultivars

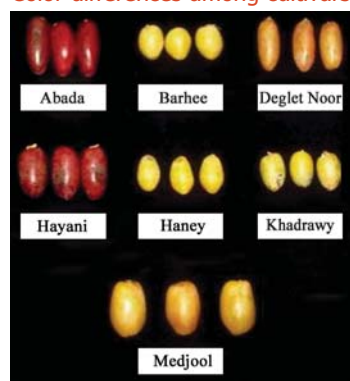


Fig. 2. Khalal stage of date development



Fig. 3. Ripening Stages of Barhee Dates



Fig. 4. Rutab stage of development of Hayany dates

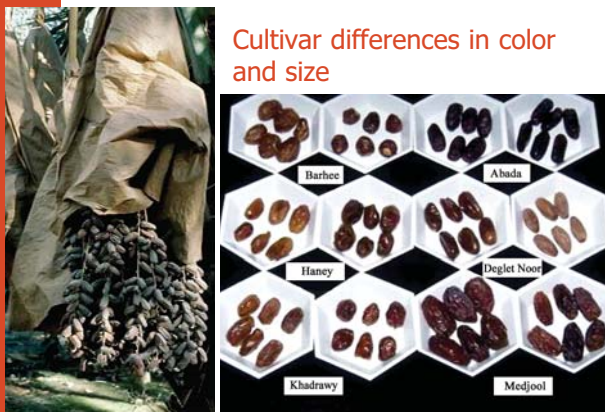


Fig. 5. Tamar (Tamar) stage of date development



Fig. 6. Tamar stage of Deglet Noor dates

A few date cultivars, such as Barhee (Barhi, Berhi), Hayany, Samany, and Zaghlol, are harvested at the "Khalal" stage (partially-ripe) when they are yellow or red (depending on cultivar), but many consumers find them astringent (due to high tannin content). Ripening of "Khalal" dates can be hastened by bunch bagging during growth. After harvest, these dates can be ripened to the "Rutab" stage by either quick freezing and keeping at -18°C or lower temperatures for at least 24 hours and thawing them, or by exposure to acetaldehyde or ethanol vapors.

Most dates are harvested at the fully-ripe "Rutab" (light-brown and soft) and "Tamar" (dark-brown and soft, semidry, or dry) stages, when they have much greater levels of sugars, lower contents of moisture and tannins (disappearance of astringency), and are softer than the "Khalal" stage dates. Moisture contents of khalal, rutab, and tamar dates range from 45-65, 30-45, and $<30\%$, respectively.

Increased sweetness with ripening of dates results from the increase in total sugars and in soft cultivars the conversion of sucrose to fructose and glucose.

Quality Indices

The date is a berry with a single seed that varies in size from 9 to 30% of the fruit weight; a smaller seed or pit and thicker flesh are preferred. Dates may be round, oval, oblong, or cylindrical in shape, depending on cultivar.

Preharvest practices that influence date quality at harvest include covering fruit bunches with paper bags to shelter them from dust, pests, and rain; and fruit thinning to reduce compactness of the bunches and increase fruit size and quality.

Quality indices include fruit size, shape, color, texture (chewiness), cleanliness, and freedom from defects (such as sunburn, skin separation, insect damage, sugar migration to fruit surface, and fermentation) and decay-causing pathogens

Sweetness: Sucrose is the main sugar in some cultivars (most of the semidry and dry cultivars) while reducing sugars (fructose and glucose) are predominant in others (most of the soft cultivars); total sugars represent about 50% (fresh wt basis) or 75% (dry wt basis). The fact that consumers vary in their preferences for degree of sweetness should be considered when targeting each cultivar to a specific market and in developing products that combine dates with other foods to reduce their sweetness or balance it with acidity when desired.

Dates contain significant levels of procyanidins or condensed tannins (cause of astringency) at the khalal stage. These tannins, which are mainly in the skin, are polymerized as the fruits ripen to the rutab and tamar stages (no astringency). Dates are the only fruit in which flavonoid sulfates have been reported. Antioxidant activity varies among date cultivars from moderate to high relative to other fruits.

Grade Standards

Quality factors in the CODEX Standard for dates include the following: (1) dates should possess the characteristic color and flavor for the variety, be of proper stage of ripeness, and be free of live insects and insect eggs and mites; (2) Moisture content of 26 to 30%, depending on the variety; (3) Minimum fruit size of 4.75g (unpitted) or 4.0g (pitted) ; (4) Absence of defects, including blemishes, mechanical damage, unripe, unpollinated, embedded dirt or sand, damaged by insects and/or mites, souring, mold, and decay. Dates and their products should be free from objectionable matter and free from microorganisms that represent a hazard to human health.

The CODEX Standard for dates includes three sizes based on the number of dates per 500g: small (>110 dates without seeds or >90 dates with seeds), medium (90-110 dates without seeds or 80-90 dates with seeds), and large (<90 date without seeds or <80 dates with seeds).

In the U.S. Standards for Grades of dates, quality score includes 20 points for color, 10 points for uniformity of size, 30 points for absence of defects, and 40 for character (well developed, well fleshed, and soft). U.S. grade A or U.S. Fancy are given to whole or pitted dates of one cultivar that achieve a score of 90 or higher. Lesser grades include U.S. Grade B or U.S. Choice, and U.S. Grade C or U.S. standard. Defects that reduce their score include discoloration, broken skin, deformity, decay, puffiness, scars, sunburn, insect injury, improper hydrating, mechanical injury, lack of pollination, blacknose, side spot, black scald, improper ripening, souring, mold, dirt, and insect infestation.

In the U.S.A., Medjool growers use a Grading standard that differentiates four grades based on fruit size and freedom from defects as follows:

Grade	Dates per kilogram	Description
Jumbo	35-42	No blemishes, skin separation, or dryness
Large	44-51	No blemishes, skin separation, or dryness
Extra Fancy	44-53	Minor blemishes, packed all sizes together
Fancy	44-57	Some dryness and skin separation, packed all sizes together

Postharvest Physiology

Respiration (carbon dioxide production) rates: <25ml/kg·hr for "Khalal" stage dates; <5ml/kg·hr for "Rutab" and "Tamar" stage dates kept at 20°C. The respiration rates increase with higher moisture content. To calculate heat production, multiply ml CO₂ / kg·hr by 440 to get BTU/ton/day or by 122 to get kcal/metric ton /day.

Ethylene production rates: <0.5 microliter/kg·hr for "Khalal" stage dates; <0.1 microliter/kg·hr for "Rutab" and "Tamar" stage dates kept at 20°C.

Responses to ethylene: We found no effect of exposing khalal stage, yellow Barhee dates to 100ppm ethylene for up to 48 hours at 20°C and 85-90% relative humidity. However, khalal stage dates may respond to ethylene action at higher temperatures (30-35°C), which are more optimal for their ripening. Rutab and tamar stage dates are not influenced by exposure to ethylene but can readily absorb the aroma of other products. Thus, dates should not be stored with garlic, onion, potato, or other commodities with strong odor.

Responses to controlled atmospheres (CA): Packaging of "Tamar" dates in nitrogen (to exclude oxygen) reduces darkening of dates and prevents insect infestation.

Yellow "Khalal" Barhee dates can be stored in 20% carbon dioxide-enriched air at 0°C and 90-95% relative humidity for up to 26 weeks as compared to 7 weeks for air-stored dates. The elevated carbon dioxide concentration is fungistatic (inhibits growth of fungi, but once the dates are transferred to air, the fungal growth will resume, especially under higher temperatures). Thus, it is important to market the CA-stored dates soon after removal from storage.



Figure 7. Roadside stand in Tunisia selling dates harvested at the khalal stage (courtesy of Dr. Elhadi Yahia)



Figure 8 . Barhee dates harvested at the khalal stage and packed into styrofoam boxes on display at the wholesale market in Amman, Jordan (courtesy of Dr. Elhadi Yahia)

Harvesting

Time of harvest is based on date fruit's appearance and texture (related to moisture and sugar content). Proper timing of harvest reduces incidence and severity of cracking or splitting of dates, excessive dehydration, insect infestation, and attack by microorganisms. Dates are harvested in August at the khalal stage or in September to December at the rutab and tamar stages.

Yellow, khalal Barhee dates are marketed on branches (strands) or bunches (Fig. 7 and 8). The whole bunches are harvested (when the dates are fully yellow) and lowered to ground level, then hung on a carrier for transportation to the packinghouse. Green to greenish-yellow and ripe (rutab) fruits are removed from the branches before packing in 5 kg-fiberboard boxes for shipment to markets. These dates should be cooled to 0°C and transported under refrigeration (0-2°C and 90-95% relative humidity) to maintain their quality (Fig. 9). Hydrocooling can be used to cool khalal dates to near 0°C in 10 to 20 minutes, depending on initial temperature, but requires effective disinfection of the water and removal of excess

surface moisture from the cooled dates before packing in the shipping containers. Thus, forced air cooling may be a better choice than hydrocooling. Use of a perforated plastic liner within the box can reduce water loss during transportation and marketing.



Figure 9. Cold storage of khalal Barhee dates in Saudi Arabia (courtesy of Dr. Abdullah Alhamdan)

Date bunches are usually covered with net covers (Fig. 10) to collect the fallen ripe fruits. As the palm tree grows taller, harvesting the dates becomes more difficult and more costly. Ladders may be mounted on the palm tree to facilitate harvesting (Fig. 11) or various types of lifts, such as tree squirrel and self-propelled elevating platform, are used to elevate the harvesting laborers (Fig. 12) to facilitate harvesting (Figs. 13, 14, and 15).



Figure 10. Net cover for date bunches (courtesy of Dr. Abdullah Alhamdan)



Fig. 13. Date Harvesting in California-2 (courtesy of Mr. David Karp)

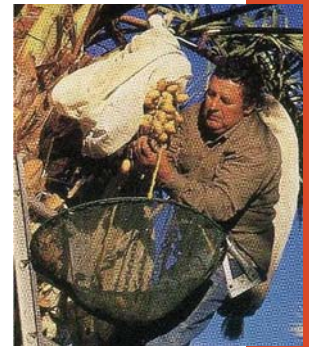


Fig.11. Ladders attached to date palm trees to facilitate harvesting



Fig. 14. Date Harvesting in California-3 (courtesy of Mr. David Karp)

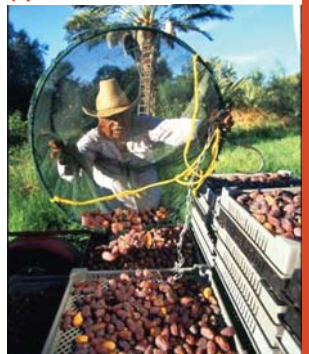


Fig. 12. Date Harvesting in California-1 (courtesy of Mr. David Karp)



Fig. 15. Date Harvesting in California-4 (courtesy of Mr. David Karp)

Rutab and tamar dates are harvested as whole bunches (when the majority of dates are ripe) that are lowered to the ground level and shaken into a bin to remove the ripe dates (Fig. 15). Alternatively, individual ripe dates are picked from the bunches and on average 3 pickings are required over several days (Fig. 13 and 14). Pickers use different types of containers and harvesting aids to lower the dates to the ground level. Fallen dates on the ground, which are more subject to mechanical damage, should never be collected and sold for human consumption because of the increased chances for microbial contamination and embedding of soil into the flesh when the dates touch the ground

Insect Disinfestation

Insect infestation and damage caused by insect feeding on the dates is one of the primary causes of postharvest losses in quality and quantity. Dates can be infested with some of the stored-products insects (such as *Oryzaephilus surinamensis*, *Oryzaephilus mercator*, *Tribolium confusum*, *Plodia interpunctella*, *Cryptolestes ferrugineus*, and *Cadra spp.*) and must be fumigated with an approved fumigant for disinfestation (Fig. 16) followed by packaging in insect-proof containers. Methyl bromide at 30g/cubic meter (30 ppm) for 12 to 24 hours at temperatures

above 16°C is very effective in insect disinfestation. Although methyl bromide may be phased out in many of its applications, its use for postharvest insect disinfestation is likely to be continued as long as it is trapped and reused. However, it is a good idea to have alternatives in case use of methyl bromide is not permitted at a future time. A potential substitute for methyl bromide is sulphuryl fluoride at 34g/cubic meter for 24 hours at 20-25°C, which was recently registered by the USEPA. Phosphine is an approved and effective fumigant, but the treatment takes 3 to 5 days at 20°C and 60% relative humidity.



Fig. 16. Fumigation chambers for insect control in dates

"Organic" dates may be treated with 100% carbon dioxide for 2 days since chemical fumigants (such as methyl bromide) cannot be used. Also, heat treatments or freezing can be used for insect disinfestation of organic dates.

Heated air at 50 to 55°C for 2 to 4 hours (from the time the fruit temperature reaches 50°C or higher) is effective in insect disinfestation. Use of forced hot air is recommended to obtain faster and more uniform heating of the dates. Use of higher temperatures is not recommended because of increased color darkening of the dates.

Cooling the dates to the desired storage temperature (0°C) soon after completion of the heat treatment reduces the intensity of color darkening.

Freezing at -18°C or lower for at least 48 hours (from the time when the fruit temperature reaches -18°C or lower) is enough to kill all life stages of stored products insects. It is important to use forced air to cool the dates to the desired temperature as fast as possible to shorten the total duration needed for insect disinfestation.

Storage below 10°C will prevent insect feeding damage and reproduction. Storage at 5°C or below will control insect infestation.

Storage in low-oxygen (<0.5%) atmospheres prevents insect activity. This can be achieved by packaging the dates in nitrogen or under vacuum.

Ionizing radiation at 0.75 to 1.0 kGy can be used for insect disinfestation.

Ripening

Freezing for at least 24 hours can be used to accelerate ripening of khalal dates to rutab stage. Freezing at -35 to -50°C is better (causes less damage to the tissues) than freezing at -1 to -18°C (causes some damage to cell membranes and walls).

Ripening enhancement of khalal stage dates can be achieved by treatment with acetic acid, ethanol, or acetaldehyde.

If picked before full ripeness to avoid damage by rain, insects, or other factors, dates need to be ripened after harvest. Ripening rooms and plastic houses with good air circulation provide optimal ranges of temperature (35°C for Deglet Noor, 35-38°C for Zahdi and Hallawi, 40-43°C for Khadrawy and Hayani, and 45-46°C for Maktom and Saidy) and 70% relative humidity. Use of higher temperatures is not recommended because it increases skin separation from the flesh of the dates. It takes 2 to 5 days to ripen the dates, depending on their ripeness stage at harvest, temperature, and relative humidity.

In general, flavor quality of dates ripened after harvest is lower than flavor quality of dates ripened on the tree.

Dehydration

Dates need to be dehydrated to the optimal moisture content for preserving their quality during subsequent handling and storage. Dehydration may be done concurrently with ripening. If ambient conditions allow, dehydration can be done using solar energy by spreading the dates on trays that will be exposed to the sun (Fig. 17) or under plastic tunnels (Fig. 18) until drying is completed to the desired moisture level. Alternatively, ambient air can be forced through the dates that are spread on stacked trays within a pallet that is covered by a shrink film with ventilation openings at the top and bottom of the pallet. Similarly, ambient-air drying can be done within plastic greenhouses with good air circulation. Drying in plastic houses, which can be constructed at a reasonable cost, protects the dates from dust, birds, rodents, and other damaging factors.

If solar or ambient-air drying are not possible, heated air must be used to dry the dates to their desired moisture content. The temperature of heated air used for drying depends on the cultivar as indicated in the ripening section.



Fig. 17. Sun Drying of Dates (courtesy of Mr. David Karp)



Figure 18. Drying dates under plastic cover (courtesy of Dr. Abdullah Alhamdan)

Over-drying to less than 20% moisture should be avoided to keep the dates soft. The desired moisture content is 23 to 25%.

Hydration

If picked ripe and not over-dried, dates do not require hydration. But sometimes, hydration is used to soften the texture of some date cultivars. Dates are dipped in hot water or exposed to steam at 60 to 65°C and 100% relative humidity for 4 to 8 hours. Steaming for 10 minutes is enough for some cultivars, such as 'Fardh'. Hydration changes the dried dates into plump and glossy dates. Forced air circulation is used to improve uniformity of temperature and relative humidity throughout the hydration room.

Pasteurization

Dates may be pasteurized by exposure to 72°C and 100% relative humidity air until their temperature reaches 66°C, where it is kept for one hour. However, such conditions may induce color darkening of the dates.

Preparation for Market



Figure 19. Washing of dates (courtesy of Dr. Abdullah Alhamdan)



Fig. 20. Sorting dates by quality

1. Initial sorting to remove defective dates and foreign materials.
2. Cleaning to remove dust, dirt, and other foreign materials using air pressure and water (Fig. 19) followed by air drying to remove surface moisture. Damp towels may be used in cleaning the dates.
3. Sorting by quality and size into grades (Fig. 20).
4. Surface coating with wax or other materials (such as vegetable oil, glucose syrup, corn syrup, date syrup, sorbitol, or glycerol) may be used to reduce stickiness and/or improve appearance (gloss).
5. In some cases, the dates are pitted and may be stuffed with nuts. Other products include date pieces that are used in cereals and other foods and macerated dates that are used in baked products.
6. Packaging (Figs. 21 to 25) to protect the dates from physical damage and moisture absorption if moisture-proof packaging material is used. Use of insect-proof packaging is highly recommended to prevent reinfestation of the dates with insects during their subsequent storage and handling steps.

7. Cooling to below 10°C (preferably to 0°C) before transportation or storage under the same temperatures (0 to 10°C) and 65-75% relative humidity. Forced-air cooling (Fig. 26) is the most appropriate cooling method for dates.



Fig. 21. Packaging of dates



Figure 22. Bulk packing of dates into fiberboard box lined with a plastic liner (courtesy of Dr. Abdullah Alhamdan)



Figure 23. Package of tamar dates from Libya (courtesy of Dr. Elhadi Yahia)



Fig. 24. Plastic package for dates



Fig. 25. Stand-up pouch of organic, pitted dates



Fig. 26. Forced-air cooling is best for dates destined for cold storage or freezing

Date Processing

Dates are marketed whole, pitted, cut into small pieces, or macerated (ground or chopped). Whole unpitted or pitted dates may be marketed loose or pressed (compressed into layers using mechanical force).

Kimri stage (green) dates may be used for pickles and chutney. Khalal stage dates may be used for jam or dates-in-syrup (dibis). Rutab stage dates may be used for jam, butter, date bars, and date paste. Tamar stage dates may be processed into date bars, date paste, or date syrup. Date processing by-products and low quality dates may be used for sugar extraction or production of sugar alcohols, citric acid, ethanol, vinegar, or baker's yeast.

Storage Conditions

Khalal dates should be stored at 0°C and 85 to 95% relative humidity to reduce water loss, delay ripening to the rutab stage, and maintain their textural and flavor quality. Packaging in plastic bags or use of plastic liner in the box help in reducing water loss.

Optimal temperature for tamar dates is 0°C for 6-12 months, depending on cultivar (semi-soft dates, such as "Deglet Noor" and Halawy", have longer storage-life than soft dates, such as "Medjool" and "Barhee"). For longer storage durations, use temperatures below the highest freezing temperature of -15.7°C. Dates with 20% moisture or lower can be kept at -18°C for more than one year, or at 0°C for one year, or at 4°C for 8 months, or at 20°C for one month (relative humidity should be kept between 65 and 75% in all cases).

Storage and transport at low temperatures (Figs. 27 and 28) is the most important tool for maintaining quality of dates because it minimizes loss of color, flavor, and textural quality; delays development of sugar spotting, incidence of molds and yeasts, and insect infestation; prevents development of syrupiness (due to conversion of sucrose into reducing sugars) and souring of excessively moist dates.



Fig.27. Cold storage facilities



Fig. 28. Refrigerated truck being loaded from a refrigerated loading dock

Relative humidity (RH) is the moisture content (as water vapor) of the atmosphere, expressed as a percentage of the amount of moisture that can be retained by the atmosphere (moisture holding capacity) at a given temperature and pressure without condensation. The moisture holding capacity of air increases with temperature. Water loss is directly proportional to the vapor pressure difference (VPD) between the commodity and its environment. VPD is inversely related to RH of the air surrounding the commodity. RH can influence water loss, incidence of some physiological disorders, and fungal growth. Condensation of moisture on the commodity (sweating) over long periods of time is probably more important in enhancing decay than is the RH of ambient air. An appropriate RH range for dates is 65-75%; at higher relative humidities, dates will absorb moisture from the room air unless they are packaged in moisture-proof containers. Water activity of 0.65 to 0.85 corresponds with moisture contents of 15 to 35% in dates. The lower the water activity, the greater the resistance to molds, yeast, and bacteria that attack date fruits.

Dates should not be mixed with onions, garlic, potatoes, apples, or other commodities with strong odors that can be adsorbed by the dates. Exposure to ammonia or sulfur dioxide can be detrimental to quality of dates.

Handling Organic Dates

The main concern in handling and storage of organic dates is to keep them separate from conventionally-produced dates and other produce items and to prevent any possibility of cross-con-

tamination of the organic produce by chemical residues that may be present on the conventionally-produced produce. Thus, it is best to use a separate storage room for the organic produce. If this is not feasible, then a physical and spatial separation of at least one meter should be maintained between the organic and conventional produce when stored in the same room. If the produce is well protected from cross-contamination by packaging, the potential for cross-contamination is much reduced.

The storage room must be thoroughly cleaned to remove any possible residues from previously stored, conventionally-produced foods. It is important to keep accurate, specific records of cleaning and sanitizing materials identified by brand name and source. A list of allowed cleaners, disinfectants, sanitizers, and other chemicals is available on the website of the Organic Materials Review Institute (www.omri.org) .

The area for food storage must be physically separate from non-foods, especially materials which can contaminate foods by odors or spillage. Packaged organic products must be received into, and dispatched from storage facilities unopened, free from damage, and correctly labeled.

The optimal storage conditions (temperature and relative humidity) are the same for organic and conventional dates. The potential storage-life for organic dates may be shorter than conventional dates if the latter is treated with approved chemicals to control decay and/or insects.

Physical and Physiological Disorders

Darkening. Both enzymatic and non-enzymatic browning occur in dates and increase with higher moisture content and higher temperatures. Enzymatic browning can be inhibited at low oxygen concentrations and low temperatures.

Skin Separation (Puffiness). Skin is dry, hard and brittle, and is separated from the flesh. This disorder develops during ripening of soft date cultivars, which vary in susceptibility. High temperature and high humidity at a stage before the beginning of ripening may predispose the dates to skin separation.

Sugar Spotting (sugaring). This disorder (Fig. 29) results from crystallization of sugars below the skin and in the flesh of soft date cultivars. Although it does not influence taste it alters fruit texture and appearance. Incidence and severity of sugar spotting increases with storage temperature and time. Storage at recommended temperatures minimizes this disorder, which occurs mainly in cultivars in which glucose and fructose are the main sugars. Sugaring may be reduced by gentle heating of the affected dates.



Fig. 29. Date sugaring (sugar spots) symptoms

Pathological Disorders

Microbial spoilage can be caused by yeasts (most important), molds and bacteria.

Souring. Yeast *species of Zygosaccharomyces* are more tolerant of high sugar content than others found in dates. Yeast-infected dates develop an alcoholic odor (become fermented). Acetobacter bacteria may convert the alcohol into acetic acid (vinegar). Yeasty fermentation results in souring of dates (due to accumulation of ethanol and/or acetic acid) with moisture

content above 25% when kept at temperatures above 20°C and its severity increases with duration and temperature of storage. Storage at low temperatures reduces incidence and severity of souring.

Decay or Mold-causing Fungi. Fungi (*Aspergillus*, *Alternaria*, and *Penicillium* spp) may grow on high-moisture dates, especially when harvested following rain or high humidity period. Growth of *Aspergillus flavus* on dates can result in aflatoxin contamination that would make them unsafe for human consumption and unmarketable.

Disease Control Strategies

1. Dry the dates to 20% moisture or lower to greatly reduce incidence of molds and yeasts.
2. Maintain recommended temperature and relative humidity ranges throughout the handling system.
3. Avoid temperature fluctuations to prevent moisture condensation on the dates, which may encourage growth of decay - causing microorganisms.
4. Use adequate sanitation procedures in the packinghouse and storage rooms to reduce potential sources of microbial contamination.

Food Safety Considerations

Safety factors in dates include natural contaminants, such as fungal toxins (mycotoxins) and bacterial toxins, and heavy metals (cadmium, lead, mercury); environmental pollutants; residues of pesticides; and microbial contamination. While health authorities and scientists regard microbial contamination as the number one safety concern, many consumers rank pesticide residues as the most important safety issue.

Unless fertilized with animal and/or human waste or irrigated with water containing such waste and become contaminated if allowed to fall to the ground, dates normally should be free of most human and animal enteric pathogens. Organic fertilizers, such as chicken manure, should be sterilized before use in date orchards to avoid the risk of contaminating the dates that contact the soil with *Salmonella*, *Listeria*, and other pathogens. Dates that touch the soil are more likely to be contaminated than those that do not come in contact with the soil. Strict adherence to "Good Agricultural Practices" during production, "Good Hygienic Practices" during postharvest handling, and "Good Manufacturing Practices" during processing are strongly recommended to minimize microbial contamination. Careful handling and strict observance of proper sanitary measures are strongly recommended to reduce microbial contamination during all handling steps. Dates should not be picked from the ground and used for human consumption because of the greater risk of contamination with human pathogens when they touch the ground.

Good Agricultural Practices (GAPs) address the following issues;

1. Water quality
2. Manure and municipal biosolids
3. Worker health and hygiene
4. Sanitary facilities
5. Field and packing facility sanitation
6. Transportation and distribution
7. Consumer packaging
8. Traceback

Good Manufacturing Practices (GMPs) focus on the following areas of food processing:

1. Personnel hygiene to prevent the spread of illness (do not allow ill workers to contact the food; supply potable water for drinking and hand washing; provide toilet facilities with hand-washing stations; establish a training program that covers worker sanitation)
2. Adequate buildings and facilities
3. Sanitary food contact surfaces, such as harvest containers, equipment and utensils
4. Process control to prevent cross-contamination

Design and implementation of the Hazard Analysis Critical Control Points (HACCP) system involves the following basic steps:

1. Identify possible food safety hazards,
2. Determine critical control points.
3. Establish preventive measures
4. Monitor the manufacturing process to detect hazards
5. Plan corrective actions
6. Prepare a method to verify that the HACCP plan is working
7. Document the HACCP system by maintaining records

It is highly recommended that date packing and processing plants establish and consistently implement a HACCP program to assure safety of their products to the consumers.

Sanitation standard operating procedures (SSOPs) are specific procedures that allow the date processing plant to achieve sanitary process control in its daily operations. These procedures include:

1. Safety and purity of the water used in all operations
2. Cleanliness of utensils and equipment
3. Prevention of cross-contamination
4. Hand washing and toilet facilities
5. Protection of food from contaminants
6. Labeling and storage of toxic compounds
7. Monitoring employee health and not allowing sick employees to touch the food
8. Pest control

Proper washing of dates significantly reduces the microbial load on their surfaces. Clean, disinfected water is required in order to minimize the potential transmission of pathogens from water to dates, from infected to healthy dates within a single lot, and from one lot to another over time. Waterborne microorganism, including postharvest plant pathogens and agents of human illness, can be rapidly acquired and taken up on date surfaces. Natural date fruit surface contours, natural openings, harvest wounds, and scuffing can be points of entry as well as provide safe harbor for microbes. In these protected sites, microbes are largely unaffected by common or permitted doses of postharvest water sanitizing treatments (such as chlorine compounds, ozone, peroxyacetic acid, and hydrogen peroxide). It is essential therefore, that an adequate concentration of sanitizer is maintained in water in order to kill microbes before they attach or become internalized in the dates.

In some countries, standards of microbial quality have been established with a maximum microbial load allowed in any of the samples tested of 1000 CFU/g yeasts, 10,000 CFU/g molds, and/or 10 CFU/g *E.coli*. Such microbial load testing may be helpful in indicating the efficacy of the sanitation procedures used to prevent microbial contamination.

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Selected Internet Sites

- <http://www.icarda.org/APRP/datepalm-> International Center for Agricultural Research in the Dry Areas, information about date production.
- <http://postharvest.ucdavis.edu> - University of California Postharvest Research and Information Center.
- <http://www.ba.ars.usda.gov/hb66/index.html> - A draft version of the forthcoming revision to USDA Agricultural Handbook 66 (Commercial Storage of Fruits, Vegetables and Florist and Nursery Stocks).
- <http://www.fao.org/inpho/> - Postharvest information site of the Food and Agriculture Organization of the United Nations.
- <http://www.poscosecha.com> and <http://www.postharvest.biz> - International Directory of Postharvest Suppliers.
- http://www.codexalimentarius.net/web/index_en.jsp - FAO-WHO Food Standards.
- <http://www.ams.usda.gov> - U.S. Department of Agriculture, Agricultural Marketing Service information on quality standards, transportation, and marketing.
- <http://www.mrlidatabase.com/> - International Maximum Residue Limit Database (Pesticide residue information).
- http://www.codexalimentarius.net/mrls/pestdes/jsp/pest_q-e.jsp - Pesticide Residues in Food.

<http://www.fao.org/ag/agn/jecfa-additives/search.html?lang=en> - FAO-WHO
Combined Compendium of Food Additive Specifications.

<http://www.ams.usda.gov/nop/> - National organic program standards.

http://www.aphis.usda.gov/ppq/manuals/pdf_files/Treatment_Chapters.html - U.S.
Department of Agriculture, Animal and Plant Health Inspection Service information on
phytosanitary and quarantine requirements.

<http://www.foodsafety.gov> - Gateway to U.S. government information on food safety.

<http://www.globalgap.org/> - Global Partnership for Safe and Sustainable Agriculture.