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# THE DATE INDUSTRY: PROCESSING TECHNIQUES AND PRODUCT APPLICATIONS.

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**Abstract:**

The date palm *(Phoenix dactylifera L.)* holds immense economic and cultural significance in Saudi Arabia's agriculture, thriving in hot arid regions despite challenges like water scarcity and declining demand. This review provides a comprehensive overview of traditional and modern processing methods, utilization, and waste management practices associated with date palms in Saudi Arabia. Traditional processing methods involve meticulous harvesting techniques, storage, maturation, drying, sorting, and packaging, ensuring the quality and flavour of dates. Modern methods incorporate mechanization, controlled ripening, advanced drying techniques, automated sorting, and innovative packaging to enhance efficiency and quality while reducing labour requirements. Dates are utilized in various food industries, including confectionery, bakery, and beverages, as date paste, syrups, and concentrates, offering natural sweetness and nutritional benefits. Traditional Middle Eastern pastries like ma'amoul prominently feature dates, showcasing their sweetness and cultural significance. Overall, the review highlights the importance of date palm cultivation, the evolution of processing techniques, and the diverse utilization of dates in Saudi Arabian cuisine and industries. It underscores the need for sustainable practices to address challenges and maximize the economic and nutritional value of date palms.

Keywords: Dates processing methods, Dates waste management, Dates utilization.

## Introduction:

The date palm, scientifically known as Phoenix dactylifera L., is a crucial element of Saudi Arabia's agriculture, thriving in hot arid regions. It holds significant economic and cultural importance, with its morphological characteristics being studied in various regions of Saudi Arabia (1)The tree symbolizes vitality and prosperity in the country, and its cultivation plays a pivotal role in the nation's agricultural landscape, representing a symbol of sustainability and resilience in the face of harsh environmental conditions. Date palm cultivation in Saudi Arabia is significant, with an annual global production of 7.5 million tons of dates, where about 10% of the total weight consists of date pits, approximately 750 thousand tons annually 2). The investment in agricultural facilities and operations by leading date producers reflects a commitment to addressing challenges like water scarcity, soil erosion, and declining demand for date fruit. This investment aligns with the need for sustainable agricultural practices to combat land degradation and promote landscape preservation(3). Date pits, a by-product of date processing, offer valuable nutritional composition, including carbohydrates, dietary fiber, protein, oil,

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natural antioxidants, and bioactive polyphenols. Date pits have potential use in medicinal supplements, cosmetics, and food products, meeting FDA recommendations for daily fiber intake (2).

Date palm cultivation faces challenges such as water scarcity, soil erosion, insect pests, and declining demand, despite being a significant crop in regions like Saudi Arabia. Leading date producers have increased investment in facilities and operations to address these challenges and enhance production capacity, while also minimizing the use of non-renewable resources (4). The genetic diversity and phylogenetic history of date palm have been studied, and advances in sequencing technologies have led to progress in date palm genomics research, contributing to the understanding of its adaptability to harsh climates and its importance in the economy (5) The utilization of date pits in various food products is increasing, offering functionalities in baked goods, dairy, beverages, meat, desserts, and condiments, due to their valuable nutritional composition and potential as natural preservatives (2)

This review article provides a comprehensive overview of the processing methods and their utilization associated with date palms Phoenix dactylifera in Saudi Arabia. This review will encompass traditional and modern techniques, highlighting the advancements made in date palm processing and utilization.

**Dates Processing Methods:**

Date palm processing plays a crucial role in ensuring the quality, safety, and shelf-life of dates, staple foods, and cultural icons in Saudi Arabia. Traditional processing methods passed down through generations, have evolved to adapt to local conditions and preserve the natural goodness of dates. The processing of dates can be carried out using both traditional and modern methods, each with its procedures and techniques.

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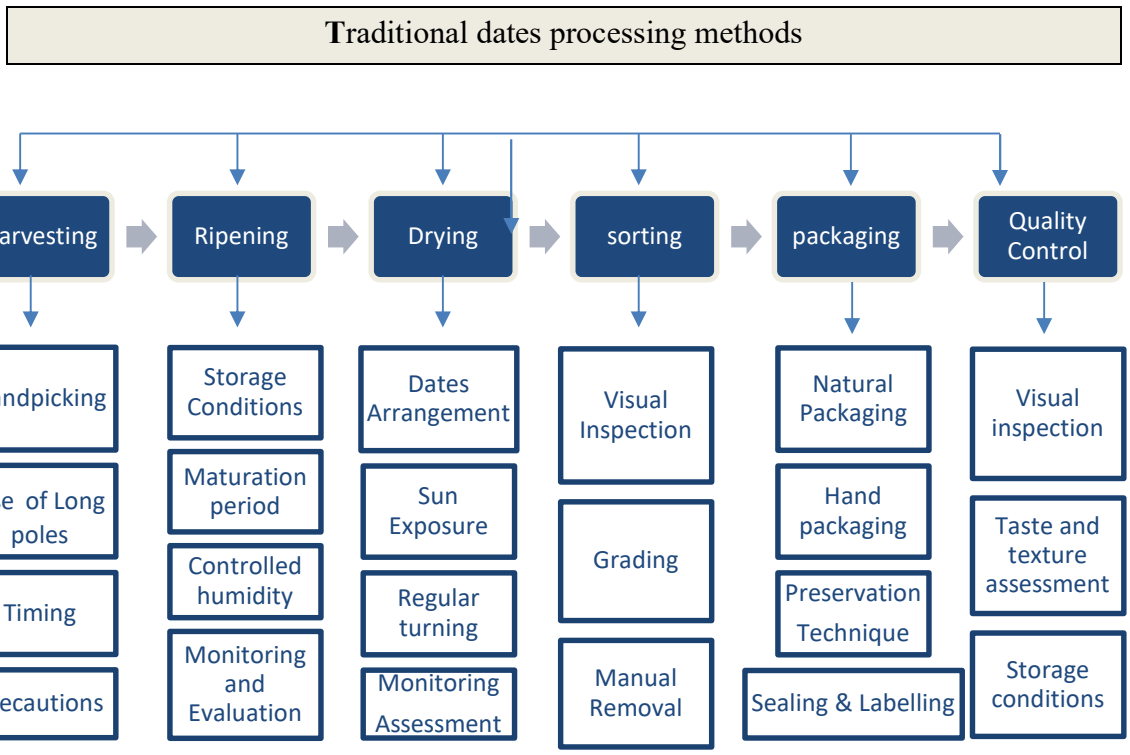
**Figure I:** Procedure of Traditional dates processing methods.




Harvesting dates involves a series of methods and considerations aimed at ensuring the quality of the fruit and the health of the palm trees. One common method is handpicking, where harvesters climb date palms and manually remove mature clusters of dates from the trees (6). This method allows for careful selection of ripe fruit while minimizing damage to both the dates and the trees. In situations where dates are located higher up in the palm trees, the use of long poles with hooks or cutters attached at the ends becomes necessary. This traditional approach enables harvesters to reach higher clusters for harvesting purposes (7). By employing long poles, harvesters can access fruit that would otherwise be out of reach, ensuring a more thorough harvest. Timing is critical in the harvesting process, as dates must be picked at their optimal stage of ripeness to ensure quality. The ideal timing varies depending on the date variety and local traditions (8). Harvesters rely on their expertise and knowledge of the specific variety being harvested to determine the precise moment for picking, ensuring that the fruit is neither underripe nor overripe. Precautions are also taken during the harvesting process to prevent damage to both the fruit and the trees. Harvesters are mindful of their actions and take care to handle the dates gently to avoid bruising or other forms of damage (9). Additionally, measures are implemented to minimize any potential harm to the palm trees, ensuring their continued health and productivity. The overall process of harvesting occurs with the continuous method of harvesting dates involves handpicking or using long poles, timed according to the optimal ripeness of the fruit, and executed with precautions to preserve both the quality of the dates and the health of the palm trees (6-7).

After harvesting, the next crucial step in the date production process involves proper storage and maturation to enhance the quality and flavour of the fruit. Harvested clusters are typically stored in a

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cool, dry, and well-ventilated area or a specialized storage facility (7). This storage environment helps maintain the freshness of the dates and minimizes the risk of spoilage. Following storage, dates undergo a maturation period where they are left to ripen for a specific duration, typically ranging from a few days to weeks. During this time, natural enzymatic processes occur, enhancing the sweetness and flavour of the fruit (6). This maturation period is crucial for developing the desired taste and texture characteristic of ripe dates. In traditional methods, controlling humidity levels around the stored clusters may be practiced preventing excessive drying or spoilage (8). Following the maturation process, dates undergo drying to reduce their moisture content and prolong their shelf life.

Throughout the ripening process, diligent monitoring and evaluation are essential. Harvesters regularly check the dates for ripeness and readiness for the next stage of processing (9). This ongoing assessment ensures that the dates are allowed to mature fully without overripening, optimizing their flavour and quality. The drying process involves several steps to ensure thorough drying and preserve the quality of the fruit. Firstly, ripened dates are arranged in a single layer on clean mats or trays, facilitating proper airflow and exposure to sunlight (7). This arrangement allows for efficient drying while preventing the dates from sticking together. Sun exposure is a critical aspect of the drying process. Dates are placed in direct sunlight for a specified duration, typically ranging from several days to a few weeks, depending on environmental conditions (6). Sunlight aids in the evaporation of moisture from the fruit, leading to the desired reduction in moisture content. Regular turning or flipping of the dates is necessary to ensure uniform drying and prevent sticking or spoilage (8). This practice helps expose all sides of the dates to sunlight evenly, promoting consistent drying throughout the fruit. Throughout the drying process, diligent monitoring and assessment are conducted to evaluate the progress. Dates are regularly checked for their moisture content, consistency, and color changes to determine the degree of drying (9). This ongoing monitoring ensures that the dates are dried to the appropriate level, balancing moisture reduction with the preservation of flavor and texture. Sorting is a next crucial step in the post-harvest processing of dates, ensuring that only high-quality fruit proceeds to subsequent stages of production. The sorting process involves several meticulous procedures aimed at identifying and categorizing dates based on various criteria. Initially, dates undergo visual inspection by experienced workers who meticulously examine each fruit for defects such as physical damage, discoloration, pest infestations, or signs of spoilage (7). This manual inspection allows for the identification and removal of any undesirable fruits, ensuring that only those meeting quality standards continue through the sorting process. Following visual inspection, dates are graded according to size, color, and quality criteria (6). They are categorized into various grades based on their appearance and condition, allowing for standardized classification and differentiation of the fruit. Manual removal of substandard or damaged dates is conducted by workers who carefully separate them from the sorted batches (8). This meticulous process ensures that only high-quality fruits proceed to subsequent stages of processing, maintaining the overall quality of the final product. Throughout the sorting process, continuous quality control checks are implemented to maintain consistency and adherence to specified standards (9). These quality checks involve ongoing assessments to verify the accuracy of sorting and ensure that all sorted dates meet the required quality criteria.

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Packaging plays a vital role in preserving the quality and freshness of dates, ensuring that they reach consumers in optimal condition. The packaging process involves several steps and considerations aimed at protecting the fruit and maintaining its natural attributes. Traditionally, dates are packed in natural materials such as woven palm leaves or traditional wooden containers . These materials offer a level of protection against physical damage while also providing adequate ventilation to prevent moisture buildup and maintain the fruit's freshness. Skilled workers are responsible for hand packing sorted and inspected dates into the chosen containers (7). Special attention is given to packing techniques to prevent bruising or damage during the packing process, ensuring that the dates remain intact and visually appealing. To preserve the quality of dates during storage and transport, packaging focuses on shielding the fruit from sunlight, moisture, and temperature fluctuations (8). Traditional preservation techniques are employed to create an environment conducive to maintaining the fruit's natural attributes, such as its texture, flavor, and nutritional value. Once packed, containers may be sealed with natural materials or tied securely to prevent contamination and preserve the dates' freshness (9). Additionally, labels may be applied to identify the date variety, origin, and grade, providing consumers with essential information about the product.

Quality control is a critical aspect of date processing, ensuring that only high-quality fruit reaches consumers. Various methods are employed to assess and maintain the quality of dates throughout the production process. Visual inspection is one of the primary methods used for quality control (9). Dates are examined for color, size, shape, and external defects to ensure they meet traditional quality standards. This visual inspection allows for the identification and removal of any fruits that do not meet the desired criteria. Manual sorting is another important quality control step (11). Workers manually sort through the dates to remove damaged, discoloured, or infested fruits. This labor-intensive process helps eliminate inferior fruits, ensuring that only high-quality dates proceed to subsequent stages of processing. Taste and texture assessment are also commonly used to determine the quality and ripeness of dates (12). Traditional processors rely on sensory evaluations to gauge the flavour, sweetness, and overall texture of the fruit, ensuring that it meets consumer expectations. Controlling storage conditions is crucial for maintaining date quality during processing (12). Factors such as temperature, humidity, and airflow are carefully regulated to prevent spoilage and maintain the freshness of the fruit. Proper storage conditions help prolong the shelf life of dates while preserving their taste and nutritional value.

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**Table I** Procedure of Modern methods of dates processing methods.

| **Modern methods of dates processing methods** |
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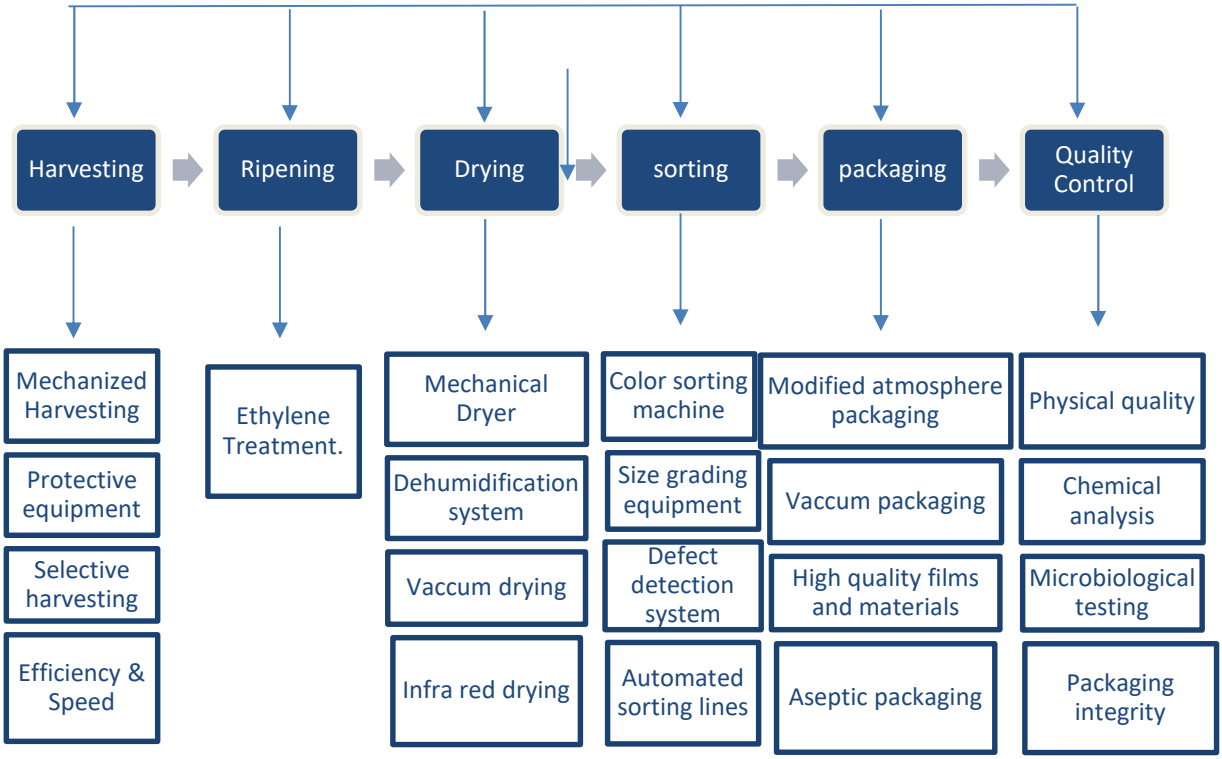


Harvesting dates has evolved with modern techniques aimed at enhancing efficiency and preserving fruit quality while minimizing labour requirements. Mechanized harvesting has revolutionized the industry, employing specialized machinery such as tree shakers or clamps to efficiently harvest mature date clusters from palm trees (14). This mechanization significantly increases the speed and efficiency of the harvesting process, allowing for larger quantities of dates to be harvested in less time. To protect both the date clusters and the palm trees during harvesting, workers may utilize protective gear and specialized equipment (13). These precautions help minimize damage to the fruit and ensure the continued health and productivity of the palm trees. Modern methods also enable selective harvesting, where only ripe clusters are harvested while unripe dates are left on the palm (11). This selective approach optimizes the quality and yield of the harvested fruits, ensuring that only fully mature dates are collected. The adoption of mechanization not only increases efficiency but also streamlines the harvesting process, reducing labour requirements (10). By mechanizing harvesting tasks, producers can achieve higher productivity levels while maintaining quality standards. Ripening dates can be expedited through the controlled application of ethylene gas, a natural plant hormone. This method is employed in controlled environments to accelerate the ripening process, resulting in enhanced sweetness and color of the fruit (14). Ethylene treatment offers a practical solution for producers seeking to manage ripening timelines and optimize the quality of their harvests. By harnessing the ripening-inducing properties of

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ethylene, producers can ensure consistent ripeness across their crop, meeting market demands and maximizing the value of their yield. (14). In date processing facilities, various drying methods are employed to remove moisture from the fruit effectively, ensuring optimal quality and shelf life. Also, the mechanical dryers play a crucial role in date processing, with types such as tunnel dryers, hot air dryers, and microwave dryers being commonly used (15). These dryers regulate temperature and airflow to facilitate the efficient removal of moisture from the dates, resulting in uniform drying and preservation of quality. Addition to this process dehumidification systems are another important component of date drying processes (14). These advanced systems create controlled environments with reduced humidity levels, which accelerates drying and ensures uniformity across the batch of dates being processed. Vacuum drying is a specialized technique utilized in date processing (13). By reducing the pressure around the dates, the boiling point of water is lowered, facilitating moisture evaporation at lower temperatures. This method helps preserve the quality of dates by minimizing heat exposure during the drying process. Finally, Infrared drying methods are also employed to efficiently remove moisture from dates (16). These methods utilize infrared radiation to penetrate the fruit and evaporate moisture quickly, resulting in rapid drying while preserving the nutritional content of the dates. Sorting dates in processing facilities involves the utilization of advanced equipment and technology to ensure the quality and uniformity of the final product. Followed by this Color sorting machines equipped with cameras and sensors play a crucial role in the sorting process (17). These optical sorting machines identify variations in colour, allowing for the efficient removal of discoloured or damaged dates from the production line. By swiftly detecting undesirable dates, colour sorting machines help maintain the overall quality of the sorted batch. Size grading equipment is utilized to categorize dates based on their size (Khalil et al., 2013). Mechanized grading systems ensure uniformity and consistency in the final product by separating dates into different size categories. This helps meet market preferences and standards while optimizing packaging and presentation. Defect detection systems utilize advanced technology such as near-infrared spectroscopy (NIRS) and multispectral imaging to identify defects in dates (18). These systems can detect issues such as Mold, insect damage, or foreign materials, ensuring that only high-quality dates proceed to further processing or packaging. Automated sorting lines, integrated with conveyor systems and sensor technology, streamline the sorting process (19). These sorting lines incorporate various sensors and air jets to automatically remove defective or substandard dates from the production line. By automating the sorting process, these systems increase efficiency and reduce labour requirements, ultimately improving overall productivity. These advanced technologies ensure that only high-quality dates are selected for further processing, packaging, or distribution. Packaging plays a crucial role in maintaining the quality and extending the shelf life of dates. Various methods and materials are employed to ensure that dates reach consumers in optimal condition. Modified Atmosphere Packaging (MAP) involves altering the gaseous composition surrounding the dates inside the package (20). Typically, oxygen levels are reduced while carbon dioxide levels are increased. This modification inhibits microbial growth and helps preserve the freshness of dates by slowing down the ripening process and reducing oxidation. Vacuum packaging is another method used to maintain the freshness of dates (21). Dates are packed in a vacuum-sealed environment, effectively removing oxygen from the package. This prevents oxidation and slows down the degradation process,

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extending the shelf life of the dates. Utilizing high-quality packaging films and materials with barrier properties is essential for protecting dates from moisture, gases, and external contaminants (24). Advanced materials such as laminated films and micro-perforated films create a protective barrier around the dates, maintaining their quality and freshness during storage and transportation. Aseptic packaging offers a solution for extending the shelf life of dates without the need for preservatives (22,23). Dates are packaged under sterile conditions, ensuring the absence of harmful microorganisms. This method helps preserve the nutritional content and quality of dates while prolonging their shelf life. To analyze the dates and their characteristics Quality control in the date industry involves monitoring physical quality parameters, conducting chemical analysis, performing microbiological testing, and assessing packaging integrity(23, 24). These measures collectively contribute to the production of high-quality dates that meet consumer expectations and regulatory requirements. Physical quality parameters, including size, color, texture, and moisture content, are closely monitored to maintain consistency and desirable attributes in dates (11). By ensuring uniformity in these physical characteristics, producers can meet consumer expectations and market standards. Chemical analysis plays a vital role in quality control, with a focus on determining sugar content, acidity, and nutritional profiles (11). Advanced techniques such as high-performance liquid chromatography (HPLC) are employed for precise analysis, providing insights into the nutritional composition and overall quality of dates. Microbiological testing is conducted rigorously to ensure the absence of pathogens and contaminants in dates (23). This testing helps guarantee the safety of the product and protects consumers from potential health risks associated with microbial contamination. Assessment of packaging integrity is another critical aspect of quality control (24). Ensuring that the packaging is intact and capable of protecting dates from external factors such as moisture, gases, and contaminants is essential for maintaining the freshness and quality of the product during storage and transportation.

**Utilization of dates**

Dates, with their nutritional richness and versatility, serve not only as a food source, but also contribute to various industries, traditional practices, and cultural customs worldwide. Dates are a staple in Saudi cuisine, used in traditional dishes like date-filled pastries ma'amoul or served with coffee as a gesture of hospitality. (11) Dates are a fundamental element of Saudi Arabian cuisine and are deeply embedded in culinary traditions and daily consumption. They are considered an essential part of the Saudi diet, serving not only as a sweet treat, but also as a symbol of hospitality and generosity. (Al-Nasseri, R. H. 2017). Ma'amoul, a traditional Middle Eastern pastry, prominently features dates as fillings. These pastries are prepared during festive occasions and celebrations, showcasing the sweetness of dates encased in delicate pastry shells. Dates are also used in various other pastries and desserts, adding natural sweetness and richness to the dishes.(25).

Dates are processed into date paste, syrups, and concentrates that are used in various food industries, including confectionery, bakery, and beverages. Date paste serves as a natural sweetener and binding agent in confectionery products, such as energy bars, candies, and sweets. Date syrup, with its rich flavour and natural sweetness, is used as an ingredient in chocolates, nougats, and other confectionery products (11). Date paste and concentrates are employed in bakery goods to enhance the texture,

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moisture, and flavour profiles. They're utilized in bread, cookies, cakes, and pastries, providing a healthier alternative to refined sugars, and enriching the nutritional content of these products (25). Date concentrates and syrups are utilized in beverage production, adding natural sweetness and depth of flavour to drinks like juices, smoothies, and shakes. These derivatives offer a healthier alternative to artificial sweeteners and flavourings (9)

**Conclusion:**

In conclusion, this comprehensive review has shed light on the significance of date palm cultivation and processing in Saudi Arabia, emphasizing its economic, cultural, and nutritional importance. Traditional and modern methods of date processing have been explored, highlighting the evolution of techniques to meet the challenges of a changing agricultural landscape while preserving the natural goodness of dates. Traditional methods, passed down through generations, demonstrate a deep understanding of the delicate balance required to harvest, store, and process dates to maintain their quality and flavour. These methods, although labour-intensive, prioritize the health of palm trees and the integrity of the fruit. On the other hand, modern techniques leverage mechanization, controlled environments, and advanced technology to enhance efficiency and consistency in date processing while meeting the demands of a growing market. Furthermore, the review has underscored the diverse utilization of dates beyond traditional consumption, showcasing their versatility in various industries, including food, confectionery, and beverage. Date-derived products like paste, syrup, and concentrates offer natural alternatives in food manufacturing while enriching the nutritional profiles of end products. Overall, the review emphasizes the importance of sustainable practices, innovation, and quality control in date palm cultivation and processing. By addressing challenges such as water scarcity, soil erosion, and fluctuating market demands, the date industry in Saudi Arabia continues to thrive, symbolizing resilience and adaptability in the face of adversity. Through a combination of traditional wisdom and modern advancements, the journey of the date palm from orchard to table remains a testament to the rich heritage and future potential of agriculture in the region.

**References:**

1. Alaida, M. F., & Aldhebiani, A. Y. (2022). Comparative study of the morphological characteristics of Phoenix dactylifera L. cultivars in Al-Madinah Al-Munawarah-Saudi Arabia. *BMC Plant Biology*, *22*(1). https://doi.org/10.1186/s12870-022-03841-0
2. Al-Khalili, M., Al-Habsi, N., & Rahman, M. S. (2023). Applications of date pits in foods to enhance their functionality and quality: A review. In *Frontiers in Sustainable Food Systems* (Vol. 6). https://doi.org/10.3389/fsufs.2022.1101043
3. FAO. (2018). *The future of food and agriculture—Alternative pathways to 2050. Food and Agriculture Organization of the United Nations, Rome, Italy.* Food and Agriculture Organization
4. Aleid, S.M., Al-Khayri, J.M., Al-Bahrany, A.M. (2015). Date Palm Status and Perspective in Saudi Arabia. In: Al-Khayri, J., Jain, S., Johnson, D. (eds) Date Palm Genetic Resources and Utilization. Springer, Dordrecht. https://doi.org/10.1007/978-94-017-9707-8_3

*ISSN:1624-1940*
DOI 10.6084/m9.figshare.2632597
http://magellanes.com/

5. Rahman, H., Vikram, P., Hammami, Z., & Singh, R. K. (2022). Recent advances in date palm genomics: A comprehensive review. In *Frontiers in Genetics* (Vol. 13). https://doi.org/10.3389/fgene.2022.959266
6. *Al-Khayri J., Jain S., Johnson D. (2015) Date Palm Biotechnology Protocols: Volume II: Germplasm Conservation and Molecular Breeding. Methods in Molecular Biology, 1224, 153-162.*
7. *Food and Agriculture Organization of the United Nations. (2006) Post-harvest Compendium: Date Palm. FAO Agricultural Services Bulletin, 101.*
8. *Al-Jaloud A., Al-Hooti S., Sidhu J. (2013) Date Palm Status and Perspective in Kingdom of Saudi Arabia. Emirates Journal of Food and Agriculture, 25(9), 686-694.*
9. *Khan M., Mahmood T., Khan A., Khan S. (2014) Date Palm: Cultivation, Processing, and Medicinal Values—A Review. Journal of Medicinal Plants Research, 8(45), 1347-1357.*
10. . *El Hadrami A., Al-Khayri J., Soccol C. (2012) Date Palm Genetic Resources and Utilization: Volume 1: Africa and the Americas. Springer Science & Business Media.*
11. . *Al-Farsi M., Alasalvar C., Morris A., Baron M., Shahidi F. (2005) Compositional and Sensory Characteristics of Three Native Sun-Dried Date (Phoenix dactylifera L.) Varieties Grown in Oman. Journal of Agricultural and Food Chemistry, 53(19), 7586-7591*
12. *Al-Shahib W., Marshall R. (2003) The Fruit of the Date Palm: Its Possible Use as the Best Food for the Future? International Journal of Food Sciences and Nutrition, 54(4), 247-259.*
13. . *Al-Alawi A., Al-Muharrmi Z., Al-Harrasi A., Yaish M. (2017) Date Palm Tree (Phoenix dactylifera L.): Natural Products and Therapeutic Options. Frontiers in Plant Science, 8, 845*
14. . *Food and Agriculture Organization of the United Nations. (2019) Dates: Post-harvest Operations. FAO Agricultural Services Bulletin, 101*
15. Abdulhadi A., Al-Yousef Y., Al-Bulushi S., Al-Jabri S., Al-Rashdi M. (2012) Date Palm Products. In: Al-Khayri J., Jain S., Johnson D. (eds) Date Palm Genetic Resources and Utilization. Springer, Dordrecht. https://doi.org/10.1007/978-94-007-2904-9_16
16. Al-Showiman S., Mohammed S., Al-Belushi H. (2003) The Effect of Drying Methods on the Quality of Omani Dates. Food Chemistry, 81(4), 519-527.
17. Maqsood M., Abid M., Siddique R., Khan M. (2017) Application of Image Processing for Sorting and Quality Evaluation of Dates. Journal of Food Process Engineering, 40(5)
18. ElMasry G., Sun D., ElSayed A., Wardle D. (2008) Discrimination of Intact and Defective Dates Using Multispectral Imaging Technique. Journal of Food Engineering, 89(3), 286-293.
19. Tohamy A., El-Din M. (2018) Design and Performance Evaluation of an Automated Date Fruits Sorting System. Journal of Automation and Control Engineering, 6(3), 207-213.
20. . Al-Maiman S., Ahmad D. (2002) Changes in physicochemical properties and reducing sugars composition of dates during storage at different temperatures and packaging conditions. Food Chemistry, 77(1), 57-63.
21. Majeed H., Yaqoob S., Javaid A., Jamil A. (2013) Effect of Different Packaging Materials on the Storage Stability of Dates (Phoenix dactylifera L.). Pakistan Journal of Food Sciences, 23(1), 10-15.
22. Soliva-Fortuny R., Martín-Belloso O. (2003) New advances in extending the shelf-life of fresh-cut fruits: a review. Trends in Food Science & Technology, 14(9), 341-353.

*ISSN:1624-1940*
DOI 10.6084/m9.figshare.2632597
http://magellanes.com/

23. Bello R., Atiku F., Sani A., Anike U., Shehu K. (2011) Microbial Load and Antimicrobial Susceptibility Pattern of Dates Sold in Sokoto Metropolis. Journal of Applied Sciences and Environmental Management, 15(3), 465-468.
24. Ali A., Muhammad Z., Mushtaq M., Khan M., Akhtar M. (2016) Effect of packaging materials and storage conditions on the quality of date fruit. Journal of Food Processing and Preservation, 40(6), 1236-1244.
25. *Roden, C. (2018). A New Book of Middle Eastern Food: The Essential Guide to Middle Eastern Cooking. As Heard on BBC Radio 4. Penguin UK.* (n.d.).