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## A Review on phytochemistry of *Phoenix dactylifera* L. fruits and seeds (Date Palm)

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### ABSTRACT

*Phoenix dactylifera* are known for their abundance of phytochemicals, including phenolics, anthocyanin, carotenoids, tocopherols, phytosterols, and dietary fibre. These phytochemicals have been associated with various biological activities, such as antioxidant, antibacterial, anti-inflammatory, prebiotic, anticancer, and antitoxic properties. Consequently, date fruits have been utilized in the prevention and management of prevalent diseases, such as diabetes, cancer, and gastrointestinal, cardiovascular, and neurodegenerative diseases, particularly in industrialized nations. *Phoenix dactylifera* possesses a wide range of pharmacological effects, which can be attributed to the presence of several potent and advantageous chemicals such as flavonoids, vitamins, minerals, amino acids, sterols, fatty acids, and organic acids. Hence, the purpose of this review is to examine the phytochemical composition of *Phoenix dactylifera* L. This investigation aims to facilitate further research on the specific compounds found in this plant species, with the intention of benefiting human health. Additionally, it seeks to promote the cultivation of *Phoenix dactylifera* as a means of ensuring sustainability for future generations.

**Keywords:** *Phoenix dactylifera*, Date Palm, phytochemistry, Medicinal, Traditional

### 1. INTRODUCTION

The *Phoenix dactylifera*, also known as the date palm, holds the distinction of being one of the most ancient trees under cultivation globally. It occupies a significant role in Arab countries, where it serves as a fundamental dietary staple. The date palm (*Phoenix dactylifera*

L.) is considered the primary arboriculture crop in the oasis regions of the Middle East and North Africa, as highlighted by Bouhlali *et al.* [1]. Dates are abundant in a variety of nutrients that possess therapeutic significance for the treatment of specific ailments. The date palm has been referred to as the "tree of life" because of its significant nutritional content and extended lifespan [2].

Date palms are classified as monocotyledonous plants, meaning they possess a single embryonic leaf. They are also dioecious, indicating that male and female reproductive organs are found on separate individuals. These plants have the ability to thrive at altitudes of up to 1500 m, if the soil is well-drained. Presently, the cultivation of these crops is observed in regions such as the Middle East, North Africa, some areas of Central and South America, Southern Europe, as well as India and Pakistan [3-5]. The global recognition of the nutritional worth and health advantages of this food is attributed to its abundance of essential nutrients and qualities that promote well-being.

The date palm exhibits dioecious reproductive characteristics. This biological attribute has significant implications for the cultivation of commercial varieties. Therefore, it is vital to assess the compatibility of a given date palm variety for commercial purposes. The date palm, characterized by its great saline tolerance, exhibits a preference for water and produces fruits that are nutritionally dense. In terms of their nutritional composition, dates are widely consumed globally, with a significant portion of consumption occurring in India. India imports approximately 350,000 metric tonnes of dates, valued at 12 billion Indian Rupees [6].

Dates are composed of a substantial amount of carbohydrates, with lipid content consisting of 14 distinct fatty acids, as well as 15 salts and minerals. Additionally, dates include protein that encompasses 23 various amino acids and proteins [7]. The phenolic chemicals found in fruit seeds, including phenolic acids and flavonoids, have demonstrated a range of advantageous properties, including antioxidant, anti-carcinogenic, antibacterial, antimutagenic, anti-inflammatory activity, as well as the potential to mitigate cardiovascular disease [8]. The properties mentioned above are of utmost importance in preventing and treating prevalent and severe illnesses in developed countries, such as cancer, diabetes, gastrointestinal disorders, cardiovascular diseases, and neurodegenerative disorders. A range of medical conditions can affect multiple organs and physiological systems. The intrinsic properties of date fruits make them a viable contender for creating functional foods. However, further investigation is required to clarify the biological mechanisms that underlie the compounds found in date fruits. This will aid in their utilization for producing and developing nutritious foods and pharmaceuticals. Recent findings in pharmacology indicate that DSEs can modulate human health through various biological mechanisms.

The observed pharmacological effects are thought to be ascribed to a wide array of phytochemicals exhibiting diverse chemical structures and a high concentration of minerals. Although pharmacological studies have been exclusively carried out on rodents and their clinical applicability has been validated, conducting *in vitro* experiments using appropriate assays can aid in understanding the mechanism of action that underlies the diverse pharmacological characteristics [9]. An escalating number of investigations are being carried out by researchers, encompassing *in vitro* and *in vivo* studies, to showcase these impacts and explicate the underlying biological mechanisms.

The researchers acknowledge that this can be a formidable undertaking due to numerous variables. Several factors have been identified in various studies as impacting the composition of dates, such as the cultivar, growth region, and circumstances, as well as the ripening stage.

The primary topic of this review pertains to the phytochemical composition of fruits and seeds of *P. dactylifera*.



**Figure 1.** *P. dactylifera* (Source: Google; mid valley trees, 2023)

## 2. PHYTOCHEMISTRY OF *P. DACTYLIFERA* FRUITS AND SEEDS

Compounds that exhibit biological activity and are produced by plants but are not counted among the vital nutrients are known as bioactive chemicals. The architectures of these bioactive substances ranged from very basic molecules to complex polymers in a wide range of degrees of complexity. The date palm's fruit is abundant in phytochemicals. Date fruit contains several bioactive components such as phenolic acids, flavonoids, carotenoids, procyanidins, anthocyanins, tocopherol and tocotrienols, and sterols. These components have been identified as potential nutraceutical agents [10-12]. The composition of these components varies based on the fruit variety and the time of harvest, the geographic location, and the soil parameters.

The mesocarp and endocarp of *P. dactylifera* fruits contain these beneficial chemicals in varying concentrations. In addition to their contributions to the fruit's organoleptic and nutritional qualities, phytochemicals are responsible [13-15].

### 2. 1. Phenolic acids

Secondary metabolites are considered one of the most crucial types of metabolites found in plants and are called phenolic acids. In recent years, phenolic acids have been the focus of a substantial amount of research due to their status as one of the foremost categories of secondary metabolites. It is essential to take into consideration the notion that the proportion of phenolic compounds is influenced by a variety of parameters, factors such as the specific cultivars, the stage of ripening, the prevailing ecological and agronomic conditions, and the location of the site can all have an impact on the outcome.

Studies that compared the phenolic content of dried and fresh dates showed that the dried dates had a significantly higher phenolic content. One possible explanation for this phenomenon

is that the desiccation procedure induces the cleavage of tannins and the development of enzymes that facilitate decomposition under elevated temperatures [16]. These phytochemicals are present in the plant's pulp and seeds; however, the pulp contains a higher concentration and a more varied set of phytochemicals than the seeds. Hence, the study conducted by Mrabet *et al.* [12], aimed to examine the phenolic acid content of date fruit pulp obtained from three separate cultivars of Tunisian origin that are privately owned.

This was conducted about phenolic acids (Smeti, Garen Gazel, and Eguwa). The researchers concluded that para-coumaric acid, gallic acid, protocatechuic acid, tyrosol, vanillic acid, and syringic acid were the principal phenolic acids determined in all the analyzed samples. Notably, gallic acid emerged as the predominant substance, with values ranging from 1.35 to 1.53 g/kg of the sample. Furthermore, it was discovered that syringic acid was detected in all of the analyzed samples. According to a study carried out by Al Juhaimi *et al.* [17], it was discovered that eleven distinct breeds of fruit extracts were found to contain significant amounts of gallic acid and syringic acid, which were identified as notable constituents of the date seeds. The presence of these acids in date seeds has been demonstrated. Djaoudene *et al.* [18], investigated the phenolic acid constituents in the seeds of eight distinct cultivars of date palm fruit cultivated in Algeria.

Ferulic acid was discovered to be the most abundant phenolic compound in the samples studied by these researchers. This was followed by vanillic acid and syringic acid. The phenolic profile of seven Algerian date varieties was analyzed by Mansouri *et al.* [19]. The study revealed the presence of p-coumaric, ferulic, and sinapic acids, along with certain derivatives of cinnamic acid and three distinct isomers of 5-o-caffeoyl shikimic acid. The aforementioned data was obtained through an analysis of the phenolic profiles of the dates. The research conducted on three different types of Omani dates has demonstrated the presence of both free (protocatechuic acid, vanillic acid, syringic acid, and ferulic acid) and bound phenolic acids (gallic acid, protocatechuic acid, p-hydroxybenzoic acid, vanillic acid, caffeic acid, syringic acid, p-coumaric acid, ferulic acid, and o-coumaric acid) [16]. Alahyane *et al.*, [20], investigated the amount of phenolic acid present in the pulp taken from 17 different date cultivars and clones grown in Morocco.

The findings of their study revealed that gallic acid demonstrated the highest occurrence among the various types of phenolic acids, with values ranging from 31.41 mg/100 g for Hak Feddan Laaneb date to 4.379 mg/100 g DW for Elahmer Chtoui date. According to a study, among the commonly occurring date breeds in Tunisia, the Mermella diversity exhibited the minimum phenolic content at 5.73 mg/100 g fresh weight, while the Korkobbi varieties had the maximum phenolic content measuring at 54.66 mg/100 g fresh weight [21].

The study conducted by El-Rahman and Al-Mulhem [22] aimed to examine the quantity of phenolic acid detected in the pulp of Rozez, a variety of date fruit cultivated in Saudi Arabia.

The phenolic acid makeup of the seeds extracted from four date fruit varieties grown in Morocco.

They reported that p-coumaric acid was the most prevalent phenolic acid examined, followed by caffeic acid, gallic acid, and ferulic acid. The composition of the aforementioned substance was found to contain a variety of phenolic acids, including but not limited to the following: gallic acid, syringic acid, 3-hydroxybenzoic acid, isovanillic acid, chlorogenic acid, para-coumaric acid, ferulic acid, meta-coumaric acid, and ortho-coumaric acid. The presence of the acid cinnamic was also detected [23].

## 2. 2. Phytosterols

The plant-derived Sterols are an important part of the membranes surrounding every plant species' cells. They have a structure similar to that of cholesterol, but the lateral chain connected to the steroid ring is different in each case [24]. These compounds are a member of a different category of lipid-soluble phytonutrients that can be found in date fruit. Sterols, also known as steroid alcohols, are a subset of steroids classified as amphipathic lipids. The group hydroxyl at the 3-position characterizes the A-ring of sterols. Phytosterols, also known as plant sterols, exhibit diverse beneficial impacts on human health [25]. Although the section of the fruit that can be eaten includes a fair amount of phytosterols, the seeds, and pollen grains are the primary producers of phytosterols. Thus, Besbes *et al.*, [26], researched the sterol concentration in the oil obtained from the seeds of two breeds of date fruit, namely Deglet Nour and Allig, collected from Tunisia. According to their findings, the total sterol content of Deglet Nour was 3,500 mg/kg, while Allig's was just 3,000 mg/kg. Kikuchi and Miki [27], examined the sterols of date fruit and found that it contains cholesterol, campesterol, stigmasterol, -sitosterol, and isofucosterol. They also found that it contains isofucosterol. The number of sterols in the oil obtained from mature *P. canariensis* seeds. The researchers reported that the seed oil had an overall sterol concentration of 336.07 mg/100 g. The predominant sterol present was -sitosterol, comprising 76.06% of the total sterol content, after campesterol (8.89%) and avenesterol (8.79%) [28].

## 2. 3. Carotenoids

Carotenoids are naturally occurring pigments soluble in fat and responsible for plants' vibrant hue. Carotenoids are a class of chemical substances produced almost exclusively by higher plants, but some algae are also capable of doing so. Due to their antioxidative properties, these substances offer the body a substantial quantity of vitamin A and protect cells from the potentially harmful impacts of free radicals [29]. Nature contains more than 600 unique pigments, which are predominantly utilized as colorants in fruits, flowers, and leaves [30]. Dates possess significant quantities of carotenoid pigments, including lutein, beta-carotene, and neoxanthin. The composition and concentrations of phytochemicals exhibit variability based on various factors such as geographical location, cultivar type, and stage of ripeness. The pulp derived from dates represents a significant and primary reservoir of carotenoid pigments. The concentrations of beta-carotene in Algerian fresh varieties Deglet Noor, Tantebouchte, and Hamraya have been documented as 6.4, 3.3, and 2.5 g/100 g, respectively. During the progression from the Khalal to the tamr stage, there is a major reduction in the levels of carotenoids.

Throughout the ripening process, there is a slight increase in the quantity of pro-vitamin A in the Deglet-Noor variety, whereas those levels decreased in the Tantebougte and Hamraya varieties [31, 32]. Carotenoids can also be found in the pulp of the fruit's seeds. The concentrations in the pulp are higher than those found in lower concentrations. Habib and Ibrahim [33], analyzed to identify the carotenoid compounds present in the oil extracted from Khalas date fruit seeds nurtured in the United Arab Emirates. The carotenoid levels of Fard, Khasab, and Khalas in fresh and dried forms were analyzed.

The findings indicate that there is a reduction in carotenoid levels during the process of sun drying. The study revealed the identification of key carotenoid compounds, namely beta-carotene (3.14 mg/kg), lutein (1.59 mg/kg), -cryptoxanthin (0.020 mg/kg), and lycopene (0.02

mg/kg). According to Habib et al. [34], the carotenoid composition of oil extracted from date seeds of eighteen cultivars consisted of lutein (0.07–0.27 mg/100 g date seed),  $\beta$ -carotene (1.18–2.68 mg/100 g date seed),  $\beta$ -carotene (0.00–0.08 mg/100 g date seed),  $\beta$ -carotene (0.03–0.49 mg/100 g date seed), cryptoxanthin (0.03–0.15 mg/100 g date seed), and lycopene (0.00–0.03 mg/100 g date seed) [16].

#### **2. 4. Procyanidins**

Fruits, veggies, nuts, seeds, flowers, and bark all contain procyanidins, which are concentrated tannins that develop into blue-violet and red colors [35]. Procyanidins were isolated from Deglet Noor dates at the maturity stages of Khalal utilizing a solvent extraction process involving acetone, water, and acetic acid. According to a chemical study, the procyanidin likely evolved as undecamers, heptadecamers, and decamers of increasing molecular weight [36].

#### **2. 5. Flavonoids**

Plants' naturally occurring flavonoid conditions and diverse health issues have been associated with its advantages, such as the decrease in destined chronic diseases, the avoidance of various cardiovascular ailments, and the inhibition of certain carcinogenic processes [37]. Thirteen various flavonoid glycosides, including luteolin, quercetin, and apigenin, were found [36], when they evaluated the flavonoid content of the Deglet Noor cultivar at the Khalal stage of maturation. The Barhi date fruit contains significant amounts of isorhamnetin (5.76 mg/100 g), hesperidin (3.53 mg/100 g), and kaempferol (2.13 mg/100 g), which are the primary flavonoids present in the fruit. Mono-, diglycosylated, and triglycosylated conjugates of luteolin and quercetin but only the diglycoside of apigenin were also found C-glycoside apigenin was found, but O-glycosides quercetin and luteolin formed the bulk of the connections [38].

The seeds contained a high concentration of flavan-3-ols, specifically catechin and epicatechin, and flavonols, namely quercetin and quercetin hexoxide, identified as the predominant flavonoids [39]. Dates are currently the only food known to contain flavonoid sulfates, according to research conducted by Bouhlali *et al.*, [23] and Hong *et al.*, [36]. Chaira *et al.* [21], recently observed that among the most renowned Tunisian dates, the maximum level of flavonoids was detected in the Korkobbi type (54.46 quercetin equivalents/100 g fresh weight). According to Hilary *et al.* [39], rutin was identified as the predominant flavonoid in four cultivars of date seed (Boufgous, Bousthammi, Jihl, Majhoul) cultivated in Morocco, which was followed by quercetin and luteolin.

#### **2. 6. Anthocyanins**

Anthocyanins are pigments soluble in water and primarily located in vacuoles. These pigments can manifest in various hues, such as red, purple, and blue. A diverse range of fruits, vegetables, cereal grains, and flowers are known to contain them, and they have been associated with potential health benefits [40]. Al Farsi *et al.* [16] conducted a study on various fresh date varieties and found that the Khasab variety had the highest concentration of anthocyanins (1.5 mg/100 g) compared to the Fard variety (0.9 mg/100 g) and the Khalas variety (0.87 mg/100 g). The study also revealed a beneficial relationship between the stages of anthocyanin and the fruit's colour. The presence of anthocyanins was exclusively detected in recently collected dates, indicating their vulnerability to degradation during the solar process.

## **2. 7. The Quantity of Tocopherols and Tocotrienols**

Tocopherols and tocotrienols, like the remainder of the bioactive chemicals, Tocopherols and tocotrienols have their content and type determined by several circumstances. The most important of these factors are the cultivar, ripening phase, and geographical area. Tocopherols and tocotrienols are crucial chemical compounds for preserving human health due to their antioxidant properties, which involve the elimination of lipoperoxyl radicals [41]. It is well known that they are very effective natural antioxidants and protect biological membranes' components. Because of this, the oil that is produced from date seeds has the potential to be regarded as a rich source of tocopherols and tocotrienols. In this context, Habib *et al.* [34], examined the tocopherol levels in seed oil derived from 18 primary breeds of date fruits cultivated in the United Arab Emirates. They discovered that all seed oil samples displayed high quantities of tocopherols. More recently, the Tocol composition of the oil was generated by diverse breeds of dates and their seeds cultivated in various geographical locations [17]. A similar study, conducted by Laghouiter *et al.* [42], investigated the tocopherol content in the oil obtained from the seed pods of nine distinct varieties of date fruits cultivated in Algeria. This study explores the tocopherol content in the oil extracted from seeds of six distinct cultivars of date fruit cultivated in Saudi Arabia. The study revealed that the quantity of tool detected in the six distinct seed oils under investigation varied between 44.73 and 110.82 mg per 100 grams [43].

## **3. CONCLUSIONS**

Dates are a food rich in nutrients and contain a diverse range of vitamins, such as A, B1, B2, B3, B6, B9, and C. The aforementioned vitamins are essential in numerous physiological processes, including but not limited to macronutrient metabolic processes, DNA synthesis, and functioning as an antioxidant to safeguard connective tissue from oxidative stress. The consumption of date fruits can benefit the body with quick energy due to natural sugars like glucose, fructose, and sucrose. These carbohydrates facilitate the provision of energy to the body promptly. Dates are a rich source of potassium, a vital nutrient that contributes significantly to maintaining a healthy neural system and the functioning of the nervous system in the human body. The flesh of dates comprises several insoluble fibers, such as cellulose, hemicelluloses, pectin, and lignin. As of late, there has been a surge in attention toward isolating bioactive compounds from dates, which have been insufficiently researched, through the implementation of novel extraction methods.

Hence, it is crucial to investigate the potential benefits of date fruits in both research and the dietary and pharmaceutical sectors. Consequently, scholars are making efforts to extract beneficial phytochemical compounds and carry out an additional examination of their mode of operation and their biological implications. The possibility of employing date seeds as a therapeutic intervention for chronic illnesses offers numerous prospects and pathways for further investigation. Once the requisite information is provided, it will facilitate a more profound comprehension and appreciation of dates' significance in our daily dietary intake. To optimize the economic and therapeutic utilization of *P. dactylifera* and its derivatives, it is imperative to conduct significant research and development efforts on the plant and its products.

The present study ought to prioritize a thorough investigation of the phytochemistry of the plant. However, additional research is necessary to elucidate the molecular mechanisms

underlying the chemicals present in date fruits. This will facilitate their application in the production and development of nourishing food products and medications.

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