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A Comprehensive Review of Phoenix (Arecaceae).

Mohamed R Elgindi[1], Abdel Nasser Singab[2], Eman MM El-Taher[3], and Mona ES Kassem[4]

[1]Department of Pharmacognosy, Faculty of Pharmacy, Egyptian Russian University, Helwan University, Cairo, Egypt.
[2]Department of Pharmacognosy Faculty of Pharmacy, Ain Shams University, Cairo, Egypt.
[3]Department of Pharmacognosy, Faculty of Pharmacy, Egyptian Russian University, Cairo, Egypt.
[4]Department of Phytochemistry and Plant Systematics, National Research Centre, Cairo, Egypt.

ABSTRACT

The objective of this study is to reach the literature reviews for Phoenix. Genus Phoenix is composed of 17 species naturally distributed in the world. It has been used for the treatment of various infectious diseases, atherosclerosis, diabetes, hypertension and cancer. The fruits of some species are rich sources of carbohydrates, dietary fibers, certain essential vitamins and minerals. This review presents a comprehensive analysis of the phytochemistry and validated pharmacological properties of the genus phoenix.

Keywords: Phoenix, flavonoids, antioxidant, hepatoprotective.

Corresponding author

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INTRODUCTION

Medicinal plants continue to provide valuable therapeutic agents, both in modern and in traditional medicine [1]. Traditional medicines are gaining importance and are now being studied to find the scientific basis of their therapeutic actions [2]. Palms "the princess of the plant Kingdom", represents one of the most important plant family with respect to human use. Coconut and palm kernel oils were recognized as health oils in Ayurvedic medicine almost 4000 years ago [3, 4].

Genus phoenix is one of the most widely cultivated groups of palms around the world, different parts of this genus are widely used in traditional medicine for the treatment of various disorders which include memory disturbances, fever, inflammation, paralysis, loss of consciousness, nervous disorders [5]. The fruits of some species are used as a detersive and astringent in intestinal troubles, to relieve fever, cystisis, gonorrhea, edema, liver and abdominal troubles and to counteract alcohol intoxication [6].

Phytochemical constituents from phoenix

Different classes of compounds have been isolated and identified from genus phoenix

Lipids

Palm oil is a form of edible vegetable oil obtained from the fruit of the oil palms (primarily the African oil palm, *Elaeis guineensis,* the highest oil producing plant). Currently palm oil accounts for about 13% of the total world production of oils and fats. Contrary to established belief, lauric and myristic acids were not the principal fatty acids in all palms [7].The major saturated fatty acid in palm oil is palmitic acid (44%), the unsaponifiable fraction of palm oil contains sterols, higher fatty alcohols, pigments, hydrocarbons, squalene and ubiquinone [8]. The fatty acid composition of *P. rupicola* seed oil was found to contain Lauric acid (20.8%), myristic acid (12.4%), palmitic acid (10.9%), stearic acid (3.3%), arachidic acid (0.5%), behenic acid (0.3%), oleic acid (4.1%) and linoleic acid (10.6%) [9].The flesh of *P. dactylifera*s contains 0.2-0.5% saponifiable oil, whereas the seeds contain 7.7-9.7% oil [10]. Investigation of the fatty acid composition in flesh and seed of *P. dactylifera* revealed the presence of saturated fatty acids including capric (0.5%), lauric (24.7), myristic (11.8%), palmitic (8.6%), stearic (0.1%), margaric (0.3%), arachidic (0.5%), heneicosanoic (0.1%), behenic (0.1%) and tricosanoic acids (0.1%) and unsaturated fatty acids including palmitoleic (0.1), oleic (48.5%), linoleic (3.3) and linolenic acids (0.4%) [11]. The major unsaturated and saturated fatty acids in four *P. dactylifera* palm cultivars were oleic (42.3%) and lauric (21.8 %) acids [12]. The lipid fractionation of *P. dactylifera* seed oil from two cultivars yielded 98.30-97.30% neutral lipids, 97.26-96.90% triglycerides, 0.25-0.18% phospholipids and 0.36-0.31% sterols. Alpha-tocopherol was the predominant component in both *P. dactylifera* seed oils (24.97–38.85%) [13]. The major unsaturated and saturated fatty acids in two varieties (Deglect Noor and Moshkan) of *P. dactylifera* palm kernel oil were oleic (38.5 & 41.6%) and lauric (23.2 & 18.5%) acids [14]. Palmitic acid was the most abundant fatty acid, 12.49%, while β-sitosterol was the most prevalent phytosterol in the lipid fraction of *P. theophrasti* fruit [15]. The essential oil collected from the seeds of *P. canariensis* was analyzed by GC/MS and retension indexes. The main fatty acids of oil were oleic (50.10%), linoleic (19.23%), lauric (10.24%), palmitic (9.83%) and stearic (7.51%) acids. α-Tocotrienol was the major tocol (66%) with the rest being γ-tocotrienol and γ-tocopherol [16].

Phenolics

Phenolic acids

Phenolic acids constitute one of the main classes of secondary metabolites and in recent years have been a subject of intense study. 3-Caffeylshikimic acid is the major phenolic compound occurred in palm flowers. Also, this compound is present in fruits of many Phoenix species as *P. dactylifera* so it may be a distinctive taxonomic marker for palm family. Other phenolic acids as *p*-coumarylshikimic acid and quinic ester of caffeic acid (chlorogenic acid) are also present [17]. Studying the phenolic acids in dried fruits of *P. dactylifera* revealed the presence of eight phenolic acids (gallic acid, protocatechuic acid, *p*-hydroxybenzoic acid, vanillic acid, caffeic acid, syringic acid, *p*-coumaric acid, and ferulic acid) [18]. Ferulic acid is also present in the leaves of *P. canariensis* [19]. Recently, the phenolic profiles of seven different varieties of ripe *P. dactylifera* fruits grown in Algeria are studied. All varieties contain *p*-coumaric, ferulic, and sinapic acids as well

as some cinnamic acid derivatives [20]. Comparative studies with fresh and dried *P. dactylifera* have shown that a significant increase in phenolic content ensues on drying, possibly due to the degradation of tannins and maturation of degradative enzymes at higher temperatures [21].

Flavonoids

C-glycosylflavones, tricin, luteolin and quercitin glycosides were reported in 125 species of Arecaceae including phoenix [22]. Tricin was isolated from the leaves of *P. canariensis* [19]. The new sulfate conjugates (quercetin 3-glucosyl sulfate, luteolin 7-glucosyl disulfate and chrysoeriol 7-glucosyl disulfate) along with the known luteolin and chrysoeriol 7-glucosyl sulfates, chrysoeriol 7-O- β-D-glucoside, chrysoeriol 7-O-rutinoside and luteolin 7-O-rutinoside has been detected in *P. dactylifera* [23]. Luteolin 7-O-β-D-glucopyranoside, tricin 7-O-β-D-glucopyranoside, tricin 7-O-neohesperidoside, isoquercitrin, isorhamnetin 3-O-β-D-glucopyranoside and rutin are present in the leaves of *P. canariensis* [24]. The presence of isoorientin, orientin 7-O-β-D-glucopyranoside, isovitexin, catechin, epicatechin in the leaves of *P. hanceana* was recently reported [25].

Procyanidins

Procyanidins are condensed tannins and the main precursors of blue-violet and red pigments in fruits, vegetables, nuts, seeds, flowers, and barks [26]. Using acetone–water–acetic acid solvent extraction method, procyanidins were extracted from Deglet Noor variety of *P. dactylifera*. Chemical analysis suggests that the procyanidin existed as higher molecular weight polymers, undecamers through heptadecamers, and decamers [27].

Triterpenes and/or sterols

The sterols of *P. dactylifera* fruit contain cholesterol, campesterol, stigmasterol, β-sitosterol and isofucosterol [28]. The leaves of *P. canariensis* contain stigmasterol and β-sitosterol [19]. β-sitosterol, lupeol and epilupeol are present in the leaves of *P. paludosa* [29]. Recently, the male flower inflorescences of *P. sylvestris* were observed to contain cholesterol, β-sitosterol and β-amyrin [30].

Carbohydrates

The sugars in both flesh and seeds of the *P. dactylifera* were analyzed. Fructose, glucose, sucrose, xylose, arabinose and galactose are present [31]. An anti-coagulant and fibrinolytic galactomannan was isolated from the seeds of *P. dactylifera* by alkaline extraction. The biological activities were improved by sulfation of this polysaccharide [32]. The polysaccharide isolated from the seeds of *P. dactylifera* consists of a backbone composed of (1→4) β-D-mannopyranosyl residues and carries a single (1→4) α-linked D-galactopyranosyl residue [33]. D-xylose and 4-O-methyl-D-glucuronic acid in a molar ratio of 5:1 were identified from seeds of *P. dactylifera*. An aldobiouronic acid from hemicellulose was characterized, the hemicellulose consists of a polymer of (1→4)-linked D-xylopranosyl residues having branches of D-xylopyranosyl and 4-O-methyl-α-D-glucopyranosyluronic acid [34].

Other phytoconstituents

P. dactylifera fruits contain Ascorbic acid, *β*-carotene, nicotinic acid, riboflavin and thiamine [35]. 21 free amino acids (leucine, α-alanine and proline were predominant), the amides aspargine and glutamine were identified in *P. dactylifera* [36]. Three cultivars of *P. dactylifera* contain vitamins A and C which possess maximum concentration in the early developmental stages [37]. The seeds of four cultivars of *P. dactylifera* were screened for their content of some inorganic compounds. Inorganic ions of K, P, Na, Ca, Mg, Fe, Zn, and Cu were found in these seeds in different quantities according to cultivar except Ca, Mn and Zn where the seeds had similar amounts of them [38]. The concentrations of selenium in the flesh of ten *P. dactylifera* cultivars collected from different regions of Saudi Arabia were analyzed by using an ultraviolet/ visible spectrophotometer. The amount of selenium was found to be in the range between 1.48 and 2.96 µg/g in the ten varieties studied [39]. *P. dactylifera* fruits contain carotenoids; lutein, β-carotene and neoxanthin [40]. A new crystalline alkaloid (Helasaoussazine) was isolated from the acetone extract of *P. canariensis* palm tree (Canary Island) *P. dactylifera* palm. Its chemical structure was based on 1D, 2D NMR, EI-MS, FAB-MS spectroscopic data as well as X-ray diffraction [41].

Biological and pharmacological activities of genus phoenix

Traditional medicinal applications

Both fruits and pits of *P. dactylifera* have been of use in the various traditional and folk systems of medicines where *P. dactylifera* palms are found to be growing [42]. *P. dactylifera* fruits are traditionally used to treat hypertension and diabetes [43]. In ancient Egypt *P. dactylifera* was used as an important ingredient in various aphrodisiac and tonic confections. The regular consumption of *P. dactylifera* palm pollen and the male flowers was believed to be an aphrodisiac and to enhance fertility [44]. Regular consumption of *P. dactylifera* is beneficial in ameliorating cough, rheumatism, burning sensation, nephropathy, gastropathy, bronchitis and sexual debility [45]. It is demulcent, expectorant, nutrient, emetic, laxative, aphrodisiac, and is good for the heart. It is prescribed for gastroenteritis, coughs, respiratory diseases, asthma, chest complaints, fevers, high blood pressure and fatigue [45, 46].

Biological and pharmacological activities

Antioxidant activity

Flavonoids present in plants possess diverse health benefits, which includes antioxidant and radical scavenging activities, reduction of certain chronic diseases, prevention of some cardiovascular disorders and certain kinds of cancerous processes [47].

The aqueous extract of *P. dactylifera* fruit was a potent scavenger of superoxide and hydroxyl radicals and inhibited iron-induced lipid peroxidation and protein oxidation in the rat brain homogenate in a concentration-dependent manner [48]. Subsequently, other investigators have confirmed these observations with different varieties of *P. dactylifera* [20, 49, 50]. Recently, the antioxidant activity of *P. paludosa* was evaluated. The study showed that ethanolic extract from the leaf exhibited prominent free radical scavenging effect [51].

Antimutagenic activity

The *P. dactylifera* fruit extract possessed antimutagenic properties in the Ames mutagenicity assay. The extract caused a dose-dependent inhibition of benzo (a) pyrene-induced mutagenecity on Salmonella tester strains TA-98 and TA-100 with metabolic activation [48].

Anti-inflammatory

Both methanolic and aqueous extract of *P. dactylifera* fruit pulp and the methanolic extract of *P. dactylifera* seeds possess anti-inflammatory activity in the rat adjuvant arthritis model in rats. The extracts increased the plasma antioxidant state (vitamin C, E, A and β-carotene) levels and decreased the levels of lipid peroxides. Of all the extracts, the methanolic extract of the pulp was most effective in reducing the foot swelling, ESR and plasma fibrinogen. The extracts increased the body weight gain and food efficiency ratio suggesting its benefit [52].

Analgesic activity

The ethanolic extract of the leaves of *P. paludosa* showed dose dependent decrease in the total number of writhings after 15 minutes of administration of acetic acid intraperitoneally in rats [53].

Antitumor activity

The glucan isolated from Libyan *P. dactylifera* possessed antitumor activity. Glucan were found to exhibit a dose dependant anticancer activity with an optimum activity at a dose of 1 mg/kg in tumour induced by subcutaneously transplanting allogenic solid Sarcoma-180 tumor cells into the right side of female CD1 mice [54].

Antimicrobial activity

Antibacterial Activity

Ethanol extract of *P. sylvestris* seeds was found active (bacteriostatic) against both gram-positive and gram-negative organisms (*Salmonella paratyphi* A and *Staphylococcus epidermidis*) with MIC (minimum inhibitory concentration) values of 481and 410 µg/mL, respectively [55]. The crude methanol, acetone and water extracts of leaves and pits of three varieties of *P. dactylifera* were tested for antibacterial action against selected gram-positive and gram-negative pathogenic bacteria. The acetone and methanol extracts showed good antibacterial activity against *Bacillus subtilis*, *Escherichia coli*, *Pseudomonas aeruginosa*, *Shigella flexeneri*, *Staphylococcus aureus*, and *Streptococcus pyogenes*, whereas the water extract had very little effect on all test bacterial species. Pits extracts of all three varieties of *P. dactylifera*s were found to be more effective than leaves extracts. MIC for *S. pyogenes* was found to be 1.3, 1.1, 1.6 and 1.4 mg/ml for methanol leaves and pits extracts and acetone leaves and pits extracts, respectively [56].

Antiviral activity

The crude acetone extract of the pit of *P. dactylifera* fruit was evaluated for its antiviral activity against lytic *Pseudomonas* phage ATCC 14209-B1, using *Pseudomonas aeruginosa* ATCC 25668 as the host cell. The *P. dactylifera* pit extract inhibited the infectivity of *Pseudomonas* phage ATCC 14209-B1 and completely prevented bacterial lysis. The antiviral activity of *P. dactylifera* pits was found to be mediated by binding to the phage, with minimum inhibitory concentration of 10 mg/ml [57].

Antifungal activity

Treatment of *Candida albicans* with the extract of *P. dactylifera* caused distortion, weakening and partial collapse of the cell wall. At high concentrations drastic damage in the form of cell lysis, leakage of cytoplasmic material and eventual cell death was observed [58]. In vitro studies have shown that flavonoids possess antifungal activities against *C. albicans* and *C. krusei*, and that their presence in the extract may have been responsible for the observed antifungal effects [59, 60].

Antihyperlipidemic activity

P. dactylifera seed fibers significantly reduced the plasma triglyceride, LDL and total cholesterol levels and increased the high density lipoprotein (HDL) levels in the rats [61]. This may be of particular importance in the light of the present evidence that the occurrence of coronary heart disease is strongly related to decreased HDL cholesterol concentration and increased LDL cholesterol concentrations.

P. dactylifera pollen grains exhibited significant reduction in plasma total cholesterol, total lipids, triglyceride, and low-density lipoprotein cholesterol. There was a significant elevation in plasma HDL of treated rats as well as a significant reduction in the liver function enzyme activities [62].

Feeding the defatted *P. dactylifera* seed flour containing diet at 1.5%, 2.5% and 5.2% to rats reduced the plasma triglycerides, total cholesterol and low density lipoprotein [63].

Hepatoprotective activity

Treatment with the aqueous extracts of the flesh and pits of *P. dactylifera* significantly reduced the elevation in plasma enzyme and bilirubin concentration and ameliorated morphological and histological liver damage in rats [64].

The ameliorative activity of aqueous extract of the flesh of *P. dactylifera* and ascorbic acid on thioacetamide-induced hepatotoxicity in rats was evaluated. Treatment with aqueous extract of *P. dactylifera* flesh or by ascorbic acid significantly reduced thioacetamide-induced elevation in plasma bilirubin concentration and enzymes suggesting that thioacetamide-induced liver damage in rats can be ameliorated by administration of extract of *P. dactylifera* flesh and ascorbic acid [65].

Nephroprotective activity

Gentamicin treatment significantly increased the plasma concentrations of creatinine and urea and induced a marked necrosis of the renal proximal tubules. Feeding of *P. dactylifera* flesh and pit extract reduced the levels of plasma creatinine and urea concentrations and ameliorated gentamicin-induced damage to the proximal tubular regions of the rat kidneys [66].

CONCLUSION

In this systematic review, the pharmacological studies conducted on genus Phoenix indicate the immense potential of this genus in the treatment of conditions such as cardiovascular disorder, inflammatory ailments including liver and kidney disorders, microbial and viral infections, cancer. The observed pharmacological properties may be attributed to the presence of a high concentration of minerals and various other phytochemicals of diverse chemical structure.

The presence of compounds such as phenolics with a potential to scavenge free radicals, increase antimutagenic effects and stimulate the immune system which may contribute towards the various pharmacological effects.

In spite of all these activities very meager work has been carried out on the chemical, biochemical, pharmaceutical and pharmacological aspects of this genus and hence extensive investigation especially on the clinical efficacy is needed to exploit the therapeutic utility of different species. As the global interest towards traditional medicines over the conventional treatment is increasing due to safe and well tolerated remedies provided by them for the chronic illness with lesser side effects this review targets genus phoenix as a good source for a potentially safe and effective plants that has important medicinal values and benefits.

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