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Date (*Phoenix dactylifera* L.) fruit and seeds: Composition, using and bioactive properties- A review

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Abstract

Date palm (*Phoenix dactylifera* L.), which has always played an important role in the economic and social life of people in arid and semi-arid regions of the world, is considered the most important food source for humans. Saudi Arabia is considered as one of the most important producers and exporters specially fort he Deglet Nour variety. It also meets many needs such as dates, edible fruits, sugar and building materials. Date fruit is used to enrich daily foods or as a natural nutritional supplement because it contains phenolic compounds, essential amino acids, fatty acids, minerals and sugars for healthy and normal organism development. The seeds, which are considered as an important waste after processing the date fruit into various beverages and sugary products, constitute approximately 6.10-18.00% of the fruit. In this review, the proximate properties, oil content, fatty acid composition, tocopherol and sterol contents and bioactive properties, using of date fruit and seed were explained.

Keywords: date palm fruit, seed, composition, bioactive properties, total phenol

Introduction

The date palm (*Phoenix dactylifera* L.) grown in dry and semi-arid regions around the world can be 15-25 m tall and 20-40 cm in cross section. The yield of dates can vary depending on the age of the tree, climatic conditions, irrigation and other agricultural factors, and there are varieties that can yield 400-600 kg of fresh product per year for up to 60 years [1,2]. Dates are considered the "tree of life" due to their high nutritional value, high yield and longevity [3]. Dates, the highest fruit crop grown in the United Arab Emirates, make up about 30% of the cultivated land [4]. The possible reasons for the differences in the nutritional composition of date seeds may be due to location differences, differences between cultivars, differences in fertilizer use, irrigation, harvest time, and post-harvest treatments [5-9]. The date palm is a palm extensively cultivated for its edible fruit [10]. In addition, the physical properties of date fruits can change according to factors such as climatic, environmental, growing conditions, fertilizer and harvest time. It has been reported that soil fertilization with chemical fertilizers such as nitrogen can affect the weight, volume, diameter and length of date fruits [11,12]. Apart from fertilization, excessive irrigation has also been reported to increase fruit weight, length and diameter of date fruits [5]. It has been reported that the factors affecting the physical properties of date fruits can also likely affect the date kernels.

The aim of the present review study is to specify the botanical properties, oil content, fatty acid composition, tocopherol and sterol contents and bioactive properties, use and curative properties of date fruits and seeds.

Date fruit and seeds. Date, one of the most important fruit crops, belongs to the Aracaceae family and is widely cultivated in Arabian Peninsula, Mediterranean, Middle East and North African countries, some parts of India and warmer regions of the USA [13-20]. Date palm is a monocotyledonous and dioecious species [21]. The date palm, one of the oldest known and cultivated fruit trees in Saudi Arabia, has been reported to have both economic and cultural impacts on the lives of local residents [13-22]. It has been reported that climatic factors and reducing the number of dates falling on palm trees can affect the physical properties of date fruits [23]. It has been reported that the use of water and organic fertilizers maintains the productivity of the date tree in most of the countries where date palm is grown. In addition, adequate irrigation, fertilization, disease prevention, pollination, and harvest and post-harvest processing techniques have been reported to be effective factors on quality date production [24-27].

Seeds have an important place in the production of a new plant generation for some plants. Seed has a place in the world date production, which reached 9 million tons in 2007, and according to FAO, approximately 960 thousand tons of date seeds were produced [8, 28-31].

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For this reason, the use of such wastes is very important in increasing the income of the date planting and related sector [32,33]. Normally, a seed consists of protein, carbohydrates and lipids. Oil provides the necessary energy more than protein and carbohydrates during the germination of seeds [34]. The oil yields of the date seeds were determined between 5.7 and 12.7% [7,8,28,29,35]. In addition, date seeds are rich in potassium, magnesium, calcium, phosphorus, sodium and iron minerals [6,8,28,29]. In addition, albumin, globulin, prolamin and glutelin constitute 5-6% of the total protein and are among the soluble proteins found in date seeds [9]. The total amount of dietary fiber in date seed is around 58%, and 53% of this amount is insoluble dietary fiber such as hemicellulose, cellulose and lignin [36-39]. On the other hand, 65-69% dietary fiber was detected in the seeds of three different date varieties, and it was reported that the reason for this difference was due to the presence of high lignin and resistant starch [36]. It can be reported that date palm seeds can be used as an important source of dietary fiber and an excellent food ingredient in foods [40,41]. It has been determined that date seed powder is used in medicines and has potential benefits on human health. Also, it has been added to animal rations to increase growth, and palm kernel extract has been reported to provide protective properties against hepatotoxicity in the liver in rats [42]. It has been reported that when various levels of palm kernel powder are added to wheat flour, there is no significant increase in dough development, time stability and degree of softening. It has been reported that the stability of the dough produced with the addition of 10% and 15% of palm kernel powder is more stable compared to the control (wheat only) [43].

Proximate composition of date fruit and seeds. It has been reported that the chemical composition of dates, which is considered an almost ideal food that provides a wide variety of essential nutrients with many potential health benefits, can vary depending on factors such as variety, soil conditions, agricultural practices and ripening [5, 44-47-50]. Several studies on macroelements and trace elements of date and date seeds were conducted [7,8,51-54]. Date palm fruit seeds due to rich in minerals, it has been reported to be of vital importance for general mental and physical health [55,56]. The amount of reducing sugar found in dates is reported to be around 70 to 78 [57]. Dates have also been reported to be rich in dietary fiber, pectin, tannin, some vitamins, minerals, very small amounts of organic acids, very little starch (or no starch at all), numerous antioxidants and antimuagenic compounds [58-64]. Changes in the chemical composition of fruits during the developmental stages of date fruits ("Kimri" (immature), "Khalal" (full, crispy), "Rutab" (ripe, soft) and "Tamr" (ripe, sun-dried)) continue. While reducing sugars increase in date fruits, sucrose content decreases in ripe dates. In addition, with the progress of ripening, the dry matter content of the fruits increases. In contrast, significant reductions in titratable acidity, tannins, pectins and moisture contents occur [65,66]. Date pits contain 8.64-12.45% moisture, 4.81-5.83% protein, 5.71-7.92% oil, 0.82-1.14% ash, 2.43-4.65% carbohydrates, 70-56-74.20% dietary fiber [28]. Date consists of 73-79% carbohydrates, 14-18% total dietary fiber, 2.0-3.2% fat, 2.5% ash, 2.1-3.0% protein, and the composition od date fruit and seeds change depending on the variety of the date fruit [6,47, 67-71]. In previous studies, date flesh and fresh date pits contained 9.7-17.7% and 8.6 and 12.5% moisture, 1.1-3.0% and 4.8-6.9% protein, 0.5-3.3% and 5.7-8.8% fat, 1.4-2.6% and 0.8-1.1% ash, 5.9-18.4% and 67.6-74.2% dietary fiber and 72.8-85.0% and 2.4-4.7% carbohydrate, respectively [6,7,28,47,67,72,73]. In another study, it was isolated with polysaccharide in date seeds and date seeds contained 5-10% moisture, 5-7% protein, 7-12% oil, 10-20% crude fiber, 55-83% carbohydrates and 1-2% ash (dw) [8,54, 74,76]. Anjum et al. [75] reported that date flesh contained 9.90-14.81% moisture, 0.2-0.4% crude fat, 1.4-1.9% ash and 2.1-2.7% crude protein. Several date pits contained 3.1-12.5 g/100g moisture, 5.0-12.5 g/100g fat, 2.3-6.9 g/100g protein, 0.84-1.20 g/100g ash and 74.0-86.9 g/100g carbohydrate [6,8,28,36,77,78]. Borchani et al. [79] reported that several date flesh contained 70.66-90.57% dry matter, 0.46-2.85% protein, 0.06-0.57% fat, 77.31-88.02% total sugar, 1.58-2.59% ash, 8.09-20.25% total dietary fiber. Date flesh contained 16.54-37.32 g/100g fructose, 19.85-44.68 g/100g glucose and 1.07-51.14 g/100g sucrose [79]. Besbes et al. [8] reported that date seeds contained 90.60-91.40% dry matter, 10.19-12.67% fat, 5.17-5.56% protein, 1.12-1.15% ash, 229-293 mg/100g K, 51.7-58.0 Mg, 28.9-38.8 Ca, 68.3-83.6 mg/100g P, 10.25-10.40 mg/100g Na and 2.20-2.30 mg/100g and 81.0-83.1 % total carbohydrate. The averages of different constituents of all date cultivars were as follow: 20.64% starch, 2.4% reducing sugar, 1.98% non-reducing sugars, 6.43% protein, 9.2% oil, 1.20% ash, 0.03% Ca, 0.244%K, 0.112%P, 0.0082%Na, 0.161% Cl, 30.4 ppm Fe, 15.7 ppm Mn, 28.84 ppm Zn and 8.1 ppm Cu [80]. Borchani et al. [79] determined 404.19-670.93 mg/100g K, 11.10-36.52 mg/100g Ca, 5.27-25.14 mg/100gNa, 30.32-89.17 mg/100g Mg and 1.06-2.30 mg/100g Fe in several date fleshs. In addition, date seeds contained 13.41-34.00 mg/100g Ca, 110.09-146.77 mg/100g P, 7.24-15.42 mg/100g Na, 175.02-240.54 mg/100g K, 58.76-89.66 mg/100g Mg, 1.32-5.05 mg/100g Fe and 1.02-1.63 mg/100g Zn. Deglet nour and Allig date pits contained 10.13 and 12.74% oil, 2.18 and 2.29% reducing sugar, 0.048 and 0.048% Mg, 0.034 and 0.026 % Ca, 0.058 and 0.070 % P, 9.57 and 10.37 mg/100g Na, 1.18 and 1.36 mg/100 gZn, 1.04 and 1.12 mg/100 g Cu, 1.89 and 1.76 mg/100 g Fe and 0.353 and 0.273 mg/100 g Mn, respectively [78]. Nehdi et al. [29] reported that the seed of palm (*Phoenix canariensis*) contained 10.20% moisture, 1.13% ash, 5.67% protein, 72.59% carbohydrate, 255.43 mg/100g K, 62.78 mg/100g Mg,

48.56 mg/100g Ca, 41.33 mg/100g P, 8.77 mg/100g Na and 3.21 mg/100g Fe. Date seeds contained 4153.3-22967.1 mg/kg (dw) K, 827.6-615.3 mg/kg Mg, 626.71-395.0 mg/kg Ca, 108.1-319.4 mg/kg Na, 27.757-70.298 mg/kg Fe, 4.835-8.358 mg/kg Cu, 5.509 -10.988 mg/kg Mn and 8.768-14.795 mg/kg Zn [29]. Bouhlali et al. [23] reported that date seed contained 15.84-19.9 g/100g crude fiber, 4.55-8.26% moisture, 4.31-6.14% crude protein, 1.097-1.3% ash and 5.66-6.97% crude oil. It has been reported that the energy values of date seeds ranged from 103.58 to 108.3 kcal/100 g (dw) [23]. In a previous study, the energy values of date seeds were found to be between 4340 kcal/kg and 4795 kcal/kg [81]. Dates contain 0.5-3.9% pectin [14]. Several date flesh contained 61 mg/100g alanine, 35 arginine, 174 aspartic acid, 174 aspartamine, 172 glutamic acid, 92 glycine, 105 leucine and isoleucine, 32 lysine, 58 serine, 50 threonine, 39 tryptophan, 58 tyrosine and 30 valine [82]. Date pit powders contained 6.6-8.3 g/100g arginine, 2.3-2.4 histidine, 3.7-4.2 isoleucine, 7.8-8.6 leucine, 4.6-5.4 lysine, 0.9-1.2 methionine, 4.3-4.7 phenylalanine, 3.7-4.1 threonine, 1.9-2.3 tyrosine and 5.5-5.9 valine [51].

Date flesh parts contain about 70% digestible sugars such as glucose, sucrose and fructose. In addition, palm flesh has been reported to contain very little dietary fiber, crude protein and fat [39]. In addition, date fruits are rich in vitamins (riboflavin, biotin, thiamine, ascorbic and folic acid) which are necessary for the body. In addition, the pulp of date fruits contains a significant amount of minerals such as calcium, iron, copper, cobalt, magnesium, fluorine, manganese, phosphorus, potassium, copper, sodium, boron, sulfur, zinc and selenium [39, 37,83]. The flesh part of the date contained approximately 0.2 to 0.5% oil, while the palm kernel contains approximately 7.7% to 9.7% oil [45,84]. In oother study, date fruit has been reported to contain vitamin C, B1 (thiamine), B2 (riboflavin), nicotinic acid (niacin), and vitamin A [85]. Dates are reported to be considered the primary fruit crop in the Sultanate of Oman, representing about 82% of all fruit trees in the country [86]. By-products such as palm kernel with high amounts of minerals, antioxidants, fatty acids profile should be evaluated in order to increase the nutritional value of some functional foods for human consumption, and it is thought that palm kernel oil should have use in medicine, cosmetics and other formulations. Several studies were studied on the composition of date seed oils [8,85,89].

Physical and chemical properties of date seed oil. Date fruit is one of the most important agricultural product. Dates provide a good source of quick energy due to their high carbohydrate amount of 70-80%, among other nutrients [46]. In previous study, saponification number, iodine value, free fatty acids, p-anisidine value, peroxide value, unsaponifiable matter, refractive index, β-carotene and chlorophyll values of date (*Phoenix canariensis*) seed oil were determined as 191.28, 26.65 g/100g,0.59%, 3.67, 3.62 meqO_2/kg, 1.79%, 1.456,5.51 mg/kg and 0.10 mg/kg [29]. The phytochemical analysis of date seed oils shows 1.083-1.813 mgKOH/g acid value, 202.33-222.74 mgKOH/g saponification value, 1.243-1.01 mewO_2/kg peroxide value and 45.40-58.02 gI/100g iodine value [23]. In other study, Acidity, saponification, iodine value, refractive index and specific gravity values of date seed oils growing in Algeria changed between 1.35 and 1.38 mgKOH/g; 204.84 and 215.87 mgKOH/g; 67.22-74.80 gI/100g; 1.4778 and 1.4792 and 0.8836 and 0.9295, respectively [90]. The chemical characteristics of oil were as follows: 54.8 gI/100g iodine number, 207.3 mgKOH/g saponification value, 1.75 mg KOH/g acid value. Date syrup obtained from the date palm fruit, citric acid production and date kernels obtained in the production of different desserts are waste products of many industries [91]. Date seed oil's peroxide values, acid value, p-anisidine value and refractive index values changed between 1.04 and 1.06 meq/kg, 1.07 and 1.79 %, 2.14 and 3.12 meq/kg and 1.461 and 1.462 nD, respectively [92]. The oil contents and total sterol contents of palm date seeds changed between 5.05% and 6.08% and 5.417 and 7.884 mg/g [90]. Iodine value, saponification value, free fatty acid, p-anisidine value and peroxide values of palm seed oil were 76.7 g/100g oil, 191.3, 0.6% (% oleic acid), p-anisidine value 3.7 and 3.6 meq O2/kg, respectively [29]. The iodine values of Deglet Nour and Allig seed oil have been reported to be 44.1 g/100g and 45.5 g/100g oil, respectively [93]. These differences in iodine values may be due to the amount of unsaturated fatty acids and the number of double bonds in palm kernel oils.

Oil, fatty acid, tocopherol and sterol contents of date seed. It has been reported that date seed oil can be considered an oleic-lauric oil, since the amount of oleic acid is very high in palm seed oil, followed by lauric acid [88]. In addition, another group of researchers [51] reported that palm kernel oil is an oleic-linoleic or oleic-palmitic type. Thus, despite the low level of unsaturation of palm kernel oil, palm kernel oil may have a different potential for use. Nehdi et al. [29] reported that palm seed oil contained 10.24% lauric, 7.51% myristic, 9.83% palmitic, 1.66% stearic, 50.0% oleic, 0.10% linoleic and 0.32% linoleic acids. Date seed oils contained 5.81-17.8% lauric, 3.12-9.84% myristic, 10.9-15.0% palmitic, 3.00-5.67% stearic, 41.3-47.7% oleic, 12.2-21.0% linoleic and 0.81-1.68% linolenic acids [8]. Boukouada and Yousfi [90] reported that date seed oils contained 21.03 – 25.66% lauric, 10.28- 11.66% myristic, 9.11-10.53% palmitic, 3.10- 3.63% stearic, 40.66- 43.91% oleic and 7.05- 7.80% linoleic acids. The amount of oleic acid in date seed oil accounts for more than 50% of the total fatty acid content and represents the major main fatty acid in the oil, followed by 19% linoleic, 10% lauric and 10 palmitic acids [29]. Deglet Nour seed oil contained 0.8% capric, 17.8% lauric, 9.8% myristic, 10.9% palmitic, 5.7% stearic, 41.3% oleic, 12.2%

linoleic and 1.7% linolenic acids [94]. Date seed oils contained 16.74-20.34% lauric, 10.23-12.25% myristic, 9.82-10.94% palmitic, 2.86-3.73% stearic, 44.92-48.38% oleic, 8.30-9.02% linoleic and 0.09-0.21% linolenic acids [23]. Boukouada and Yousfi [90] reported that date seed oils contained 21.03-25.66% lauric, 10.28-11.66% myristic, 9.11-10.53% palmitic, 3.10-3.63% stearic, 40.66-43.91% oleic and 7.05-7.80% linoleic acids. Date pit oils contained 3.12-18.23% myristic, 0.42-15.09% palmitic, 1.71-46.93 g/100g stearic, 36.51-55.10 g/100g oleic and 4.33-21.00 g/100 g linoleic acids [7,29,85,93,95,96,97]. Biglar et al. [98] reported that date seed contained 4.60-7.72% oil, and these oil samples contained 18.78-31.61% lauric, 4.73-19.66% myristic, 8.33-12.14% palmitic, 1.48-3.89% stearic, 33.38-51.40% oleic and 5.30-7.88% linoleic acids. The tocopherol contents of date seeds changed between 0.61 and 18.81 µg vit E/g kernel [98]. The tocopherol's antioxidant strength arranged as δ>γ>β>α [99]. The palm (*Phoenix canariensis*) seed oil contained 0.61 mg/100g α-tocopherol, 0.92 mg/100g β-tocopherol, 10.30 mg/100g g γ-tocopherol, 1.03 mg/100g δ–tocopherol, 34.01 mg/100g mg/100g α-tocotrienol and 4.63 mg/100g γ-tocopherol [29]. Nehdi et al. [29] reported that palm (*Phoenix canariensis*) seed oil contained 1.42 mg/100g cholesterol, 29.90 mg/100g campesterol, 3.69 mg/100g stigmasterol, 255.63 mg/100g β-sitosterol, 29.56 mg/100g δ5-avenasterol, 9.20 mg/100g δ5,24-stigmastadienol, 2.68 mg/100g δ7-stigmasterol and 3.99 mg/100g δ7-avenasterol. The sterol amounts of date seed oils were detected between 5.41 and 7.88 mg/ g [90].

Using of date fruit and seed. The date palm, ne of humanity's oldest cultivated plants, has been used as food for 600 years and is used for future generations due to its environmental benefits as well as its exceptional nutritional, health and economic value. The date fruit, which contains a significant amount of carbohydrates, salt and minerals, dietary fiber, vitamins, fatty acids, amino acids and protein, is very valuable in terms of human nutrition [2]. It is sold commercially and processed into various food products and consumed as flesh or dried dates. Dried dates can be stored all year under suitable storage conditions [8, 100]. Besides direct consumption of date fruit, they are used as ingredients in the composition of foods such as spreads, syrups and fermented products (vinegar and organic acid production), and bakery products. In addition, by-products such as seeds, which are produced as a result of processing dates into these products, can be used for different purposes as a source of dietary fiber [2]. Date fruits are also used as an ingredient in desserts, snacks, confectionery, bakery products [101]. Previous studies have shown that bread made with the addition of palm kernel powder has good sensory properties and quality and is a good source of fiber for foods [102,103]. Significant amounts of date seeds can be collected from the date processing industries or waste products [98].

The oil extracted from the palm seed can be widely used in cosmetics, pharmaceuticals and food products [8,88]. Date seeds, which are considered as waste, can be used for animal feeding or for making decaffeinated coffee [28]. Ground date kernels, considered as fruit processing waste, are currently used predominantly in animal rations in the cattle, ovine, camel and poultry industries. It is also used as a food additive in foods [7,104]. In addition, date fruit seeds are often used as supplementary feed materials or conventional soil fertilizer for animal, poultry and fish feed [105,106]. Date beans are used to make a decaffeinated beverage that can replace decaffeinated coffee, and it has recently been introduced as a coffee substitute palm kernel powder, and this product has been used in the Arab world for centuries [7]. Date kernels are potentially used in the production of functional foods and to increase the nutritional value of various food products, such as increasing the fiber content of bakery products [28]. It has been reported that palm kernel powder, which is considered to be a waste by processing its fruits as a result of date production, which has increased greatly in the world in the last 30 years, is used to remove 90% phenol and p-nitrophenol (causing unpleasant taste and odor in drinking water) from wastewater. In addition, the removal of these substances from wastewater varies depending on pH, adsorbent dose and contact time [107]. Also, date seed powder was used to remove methylene blue from the aqueous solution, and palm kernel ash showed significantly higher efficiency in removing boron (71%) and phenol from drinking water compared to power plant ash, pine wood fly ash and coagulants [108-110]. Date kernels are the waste product of many date processing plants that produce pitted dates, date powder, date syrup and juice, chocolate-covered dates and date confectionery [7]. Date palm sap is consumed directly as a fresh, horse-drawn, clear, translucent and rapidly fermentable beverage called "Lagmi" and the fresh sap has prugative properties [111]. The date sap (male) contained 12.84% dry matter, 92.29 g/100g total sugar, 5.14% protein and 2.57% g/100g ash [112]. The seed, the main by-product of the date palm processing industries, can be considered an important source of dietary fiber in food..

Bioactive Properties

The concentrations and ratios of phytochemicals such as sterols, phenolics, carotenoids, procyanidins, anthocyanins and flavonoids that contribute to the nutritional and organoleptic properties of date fruit pulp depend on the fruit harvesting stage, fruit type, location and soil conditions [113,114]. The total phenolic content in the date seed was determined as 48.64 mg/100g and the gallic acid, protocatechic acid, p-phydoxybenzoic acid, vanillic acid, caffeic acid, p-coumaric acid, ferulic acid, m-coumaric acid and o-coumaric acid found in the date seed. acid forms the main phenolic acids [39].

The phenolic contents of hexane and methanol extracts changed between 4.866 and 5.648 mgGAE/g to 2.288 and 3.309 mg GAE/g, respectively [75]. Antioxidant activity values of date varieties extracted with methanol and hexane changed between 85.75 and 90.96% to 60.42 and 77.68%, respectively [75]. Mistrello et al. [115] determined 2058-2983 mgGAE/ 100g gallic acid and 1271-1932 mgCE/100g flavonoids in date seeds. In addition, Al Juhaimi et al. [81] determined 1.98-4.65 mg GAE/100g gallic acid in date seeds. Hydroxytyrosol, protocatechic acid, tyrosol, gallic acid, caffeic acid, p-coumaric acid, and oleuropein were the most abundant phenolic compounds in Deglet Nour seed oil, and were also detected in 3,4-dihydroxyphenylacetic acid in Allig seed oil [93,116]. The phenol content in palm kernel oil was also found to be higher than olive oil, and it was reported that it could be a good source of natural phenolic compounds [116]. In another study, the total phenol content of of various date seeds was determined as 2015 µg gallic acid/g [117]. The antioxidant activity values of date seeds ranged from 10.966 to 22.86 mmol Trolox equivalent/100g dw [23]. The phenolic and flavonoid contents of date seed extracts varied between 2697 to 5342 mg GAE/100g and 1224 to 1844 mg Rutin equivalent (RE)/100g, respectively [23]. Date seeds have been reported to have nutraceutical, pharmaceutical and medicinal uses [118]. It was observed that the total phenolic contents and antioxidant activity values of date seeds varied between 21.0 and 62.0 mgGAE/100g and 580 and 929 ml Trolox equivalent/g, respectively [6,77]. The polyphenol contents of acetone extracts were 54, 55 and 62 mgGAE/g date pit powders at 22, 45 and 60 ^{o}C, respectively [77]. Date fruit seeds contain high amounts of phenolic compounds with a wide variety of nutritional and functional properties [6]. The main reason why aqueous date extracts have strong antioxidant activity is attributed to the wide variety of phenolic compounds in dates, including p-coumaric, ferulic and sinapic acids, flavonoids and procyanidins [46,119,120].

Healing Effect

Since the fruits and seeds of each date variety have different phytochemicals, the fruits and seeds of the date are preferred not only for their nutritional properties, but also for their functional and technological properties [121]. Date by-products that are safe for human consumption are used as ingredients in functional foods and nutraceuticals, pharmaceuticals, and some traditional medicines [6,42, 122, 123]. In addition, citric acid and protein are produced from date seeds by *Candida lipolytica*, *Aspergillus oryzae* and *Candida utilis* [124]. While palm seed oil is used as a liniment for lazy tumors, they show antimicrobial activity against some microorganisms such as Escherichia coli, alpha and beta hemolytic Streptococci, *Aspergillus fumigatus* and Staphylococcus aureus. In addition, palm seed oil finds various applications in pharmaceuticals, cosmetics and many food products [48,51,25,126-130].

Akbari et al. [92] reported that date seeds contained 8.1-9.1% oil. After oral administration of 10 and 15% palm kernel fortified bread to the Diabetic groups, a significant decrease in blood sugar was observed 45 days later, and the reduction in sugar value reached 119.85 and 105.60 mg/dl, respectively, compared to the control, and the HbA1c ratios were decreased 9.33% and 14.21%, respectively. The reduction rates in sugar value were 21.46% and 30.79%, respectively [43]. It has been stated that treatment with bread fortified with date seeds can increase the activity of the enzyme glucose 6-phosphate dehydrogenase through increased insulin secretion, which accelerates the flow of glucose to the pentose monophosphate shunt in an attempt to lower high blood glucose levels [92]. It was observed that the increase in insulin increased to levels as high as 92% and 101% with the consumption of 10% and 15% palm kernel powder enriched bread compared to the positive control group. It has been reported that this increase in insulin release may possibly be due to increased pancreatic secretion from existing beta cells. Thus, it has been documented that palm kernel powder can reduce hemoglobin (HbA1c) levels and improve glycemic control when used in a healthy diet [131,132]. The effect of breads enriched with 0% and 15% palm kernel powder on the kidney function of diabetic rats was investigated, and it was reported that diabetes is among the leading causes of kidney failure, and ten to twenty percent of people with diabetes die from kidney failure [43,133]. Recently, date palm and its derivatives have been reported to have various therapeutic properties, and date extracts given to women after childbirth have been reported to stimulate the immune system of women [134]. On the other hand, a polysaccharide isolated from date fruit has been reported to exhibit antitumor activity, and palm kernel extracts have been reported to rapidly and significantly reduce women's wrinkles [135,136].

The extracts of date seeds extracted in water and alcohol exhibited a strong antimicrobial activity against *Klebsiella pneumonia*, *Escherichia coli* [53,137], *Staphylococcus aureus*, *Proteus vulgaris* and *Bacillus subtilis* [138]. The extract of date seeds showed to impare the cytotoxicity of azoxymethane reduced cancer in colonic tissue in rats [139]. It has been reported that a very significant improvement in the altered hepatic MDA and GSH content of cirrhotic rats was observed with oral administration of date extract and ascorbic acid to rats [18]. It has been reported that palm extracts are listed in folk remedies for the treatment of diabetes, liver diseases, and gastrointestinal disorders in traditional Egyptian medicine [140,141]. In some studies, date fruit seed extract has been reported to ameliorate gastric ulceration in rats and has an anti-inflammatory activity in a rat adjuvant model of arthritis [104,142]. In addition, it has been reported that administration of lean palm seed meal to rats reduces plasma triglycerides, total cholesterol, and low-density lipoprotein [143].

It is thought that date fruits and seeds may have an effect on human health due to the vitamins, amino acids, fat, protein, bioactive components, phenolic components and other phytochemicals in their composition [144-146]. For this reason, it is thought that different parts of consumable herbal materials should be made ready for use as food supplements. Because of these nutrients and phytochemicals in the palm kernel, the use of palm seed flour can be encouraged to fortify food industry products.

Conclusion

Dates, which are a good source of energy, contain ascorbic acid, carotenoids, flavonoids and polyphenols and have a good antioxidant potential. In addition, date seed is rich in other components such as protein and minerals, and considering the fatty acid composition of palm kernel oil, it is recommended to use this oil for nutritional purposes. Date are known for their nutritional value. Dates could have an important all-round tole to play in dietary health. Date fruits are inexpensive to preserve and have a very high nutritional value, as they contain other components that may have useful functional properties. For this reason, it is necessary to increase the production of dates and to make agricultural applications enriching the components. Dates contain nutrients, dietary fiber, bioactive compounds with health functionality, as well as rich sources for palm water purification and biomass production. Date seed oil, rich in oleic and linoleic acids, has found wide use in cosmetics, pharmaceuticals, food, and even other new applications such as body creams, shaving soap and shampoos. Date seed powder, which can also be used in foods as an important source of dietary fiber, can be considered a technologically excellent food ingredient, and date seeds contain oil with high oxidative stability. As a result, both the date fruit and the date kernel, which is considered as a waste, can be used as food ingredients in the food industry due to the phytochemicals they contain and it is claimed to have beneficial effects on human health.

Compliance with Ethics Requirements. Authors declare that they respect the journal's ethics requirements. Authors declare that they have no conflict of interest and all procedures involving human or animal subjects (if exist) respect the specific regulation and standards.

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