Emirates Journal of Food and Agriculture. 2023. 35(1): 1-16
doi: 10.9755/ejfa.2023.v35.i1.2963
http://www.ejfa.me/

REVIEW ARTICLE

The health values of *Phoenix dactylifera* (dates): A review

Nosiba A. Alsarayrah[1], Eshaifol A. Omar[1]*, Saud M. Alsanad[2], Hasni Arsad[1], Mubark M. Abudahash[3], Fouza K. ALEnazi[3], Naif D Alenzi[3]

[1]Advanced Medical and Dental Institute, Universiti Sains Malaysia, Bertam, 13200 Kepala Batas, Pulau Pinang, Malaysia, [2]Imam Mohammad Ibn Saud Islamic University, Riyadh 11564, Saudi Arabia, [3]Research and Laboratories Sector, National Drug and Cosmetic Control Laboratories (NDCCL), Saudi Food and Drug Authority, Riyadh, Saudi Arabia

ABSTRACT

Dates are one of the most prominent types of fruits spread in the Middle East and North Africa and have been an essential part of the diet of the Arab world since ancient times. It has been called "nature's candy" due to its sweet taste, which is attributed to its high sugar content. Date fruits have great nutritional and therapeutic value, due to the variety of elements they contain, as they contain a good percentage of fiber, vitamins, and minerals, especially magnesium, potassium, selenium, calcium salts, and fatty acids (*lauric, linoleic, palmitic,* and *citric acid*) as well as an excellent source of antioxidants (flavonoids, polyphenols, and carotenoids) which offer significant health-promoting and disease-fighting benefits. In this review, the origin of the date palm fruits was studied, and the nutritional value was compared between three types of dates (Ruthana, Sukari, Ajwa) in terms of the nutritional components and the therapeutic values, which is proven by several studies. The nutritional content of date fruits; sugars, beneficial fats, nutritious proteins, and phytochemicals was reviewed. The health benefits of date fruits include their ability to inhibit free radicals, anti-inflammatory activity, cytotoxicity on cancer cell lines, and the applications for its use as a functional food were indicated. The exact mechanisms still need further research and exploration, specifically, Ruthana fruits as this type of available literature showed a research gap that could be investigated.

Keywords: Date palm; Phoenix dactylifera L; Nutritional composition; Health benefits; Functional food

INTRODUCTION

Historically, numerous plant species have been investigated and used in the treatment or prevent the development of various diseases. Factors such as the rise in population number, inadequate supply of drugs, the prohibitive cost of treatment, side effects of several synthetic drugs, and arising of new diseases with the development of resistance to currently used medicaments have led to increased emphasis on the use of plant materials as a source of medicines for a wide variety of human ailments (Siddiqui, 2011). Existing menus advocate the consumption of beneficial nutrients based on their main content of vitamins, minerals, and bioactive compounds, which provide significant protection against many diseases (Micha et al., 2017). The scientific community seeks through research and exploration to reach effective strategies in controlling diseases, which may reduce the heavy burdens on individuals and countries and avoid side effects and negative effects resulting from the use of manufactured drugs.

Fruit is a major component of the human diet, and the World Health Organization recommended the importance of eating it and including it in the daily diet based on its components of vitamins, minerals, carbohydrates, fiber, minerals, and other elements that contribute to promoting public health. Date fruit is one of the most important fruits in the Middle East and North Africa. It provides nutritional and functional values. Date fruit has been recommended by several studies conducted in vitro and in vivo due to its richness in various nutrients, in addition to biologically active compounds such as antioxidants, which reflect a clear impact on human health. As a result, it contributes to the reduction or treatment of many diseases such as infections.

Accordingly, this article has come to provide a synthesis of the previously available literature on the nutritional and phytochemical content of date fruit. As well as the results of previous studies on the biological efficacy and the effect of different date extract on human health. On the other hand, the inclusion of date fruit into the functional food industry.

***Corresponding authors:**
Eshaifol A. Omar, Advanced Medical and Dental Institute, Universiti Sains Malaysia, Bertam, 13200 Kepala Batas, Pulau Pinang, Malaysia.
E-mail: eshaifol@usm.my

Received: 20 March 2022; **Accepted:** 22 December 2022

1. Classification of the date palm tree and the stages of fruit growth.
2. Comparison of the nutritional content of different types of date fruit.
3. The effect of dates with their different parts on human health, based on previous studies.

ORIGIN AND GROWING AREAS OF THE DATE PALM

The date palm (Phoenix dactylifera L) is a woody tree belonging to the Arecaceae family (Angiosperms, monocotyledon) as indicated in Table 1. It consists of about 200 genera and more than 2,500 species (Al-Alawi et al., 2017). The species name Dactylifera derives from the Greek word "Dactylus" meaning "toed bearer" and this meaning refers to the fruit groups produced by this tree. The flowers of the date palm are characterized by their small size and yellow color, which later develop through the stages of growth and maturity with different sizes and characteristics according to the variety. Fig. 1 shows the fruitful date palm tree.

The date palm believed back to that the origin of the date palm dates to the southern regions of Iraq 6000 years ago, then it cultivated spread to many countries due to its adaptive ability to live and grow in semi-arid and arid conditions and produce many fruits. Including the Middle East, North Africa, and Southern Europe. Afterword, date cultivation was introduced to new areas in Australia, India, Pakistan, Mexico, southern Africa, South America, and the United States (Rambabu et al., 2020).
What distinguishes the date palm tree is the ability to grow and produce in a dry and extremely hot climate, with little rain and very low humidity throughout the period (from pollination to harvest). It can grow between temperatures (17.5 - 27.5 °C) and tolerate up to 50 °C. The percentage score between (21-27) on average is the ideal degree for growth and production. The readings and requirements differ relatively according to each variety. Varieties that produce dry fruits grow in dry areas, while varieties with moisture grow near oases and groundwater, and it is preferable to plant them in deep, light soils. The date palm can tolerate high levels of salinity, and the salinity that grows in some varieties may reach 22,000 parts per million (Al-Khayri et al., 2015).

The agricultural production of dates constitutes a basic base in the economy of many countries, especially in the Middle East, North Africa, and South America. In addition to its great spiritual and cultural importance to the people of the Middle East. Its trees are also planted to provide cover for the most delicate trees, such as citrus fruit trees,

Table 1: Botanical description

Kingdom	Plantae
Subkingdom	Tracheobionta
Super division	Spermatophyta
Division	Magnoliophyta
Class	Liliopsida
Subclass	Arecidae
Order	Arecales
Family	Arecaceae
Genus	Phoenix
Species	P. dactylifera

Fig 1. Date palm tree.

as they provide adequate shade to protect from the heat of the summer sun as well as shelter from the strong winds in the winter. Among the most producing countries for dates are Saudi Arabia, Egypt, and Iran, while India is one of the most consuming countries (Farag et al., 2021).

The date palm is considered one of the essential agricultural sources in the kingdom of Saudi Arabia. The production of dates in the world annually is (1.3 million tons) with more than 28 million date palm trees (KSA General Authority for Statistics, 2015), while Egypt produced (1.6 million tons), whereas the productivity of Algeria, Iran, and Oman (1.1, 1.2, 0.4 million tons annually), respectively (Siddiqi et al., 2020). In general, the annual global production of dates is between (6-8 million tons), which represents a market value of more than 1 billion US dollars.

The date palm has been mentioned as the "tree of life". Is cultivated for its sweet fruits that stimulate the energy of the body, its nutritional value, and its many medicinal properties. consumed after harvesting fresh or sun-dried with no or little processing. The pericarp surrounding the seeds is the edible part of this fruit. While the seeds, which constitute approximately 10-15 percent of the fruit mass, are processed for use in fertilizers and animal feed (Radfar et al., 2019).

THE CLASSIFICATION AND GROWTH STAGES OF DATE FRUITS

Date fruits classified based on shape, size, and color, which are vary significantly according to the maturity stage based on the physical properties and their taste, the quality of dates is determined. Date fruits process five stages until they ripen. Each stage bears a somewhat different name according to the culture of the country of origin.

Hababouk stage

The first stage of fruit formation after fertilization extends between four to five weeks, the fruit is immature (Fig. 2a). It's completely covered with the calyx only one end of the ovary appears, and its weight does not exceed 1g (Hussain et al., 2020).

Kimri satage

It's also called the green stage, which is considered the longest stage in the development of date fruits. It takes between nine to fourteen weeks, varying on the type of date. It transits to the solid green fruit, which is still inedible (Fig. 2a). The average weight of the date fruit in the Kamiri stage is approximately 6 g (Tafti and Fooladi, 2006).

Khalal stage

In the Khalal stage, the color of the fruit begins to change from green to yellow or red (depending on the type of dates) as in (Fig. 2a). The nutritional content of the fruit at this point is (2.7% protein, 0.3% fat, 2.8% ash). Several date varieties can be eaten at this stage (i.e, Halawi, Barhi and Zaghloul) (Tafti and Fooladi, 2006).

Rutab stage

This stage is also called the soft ripe stage, it extends between two to four weeks, the top of the fruit begins to ripen, the texture becomes soft, and the color begins to turn brown or black (Fig. 2a) depending on the type and because of the low moisture content the weight decreases. The content of sugars increases, so it becomes sweet, and this is the appropriate stage for harvesting and storage (Baliga et al., 2011).

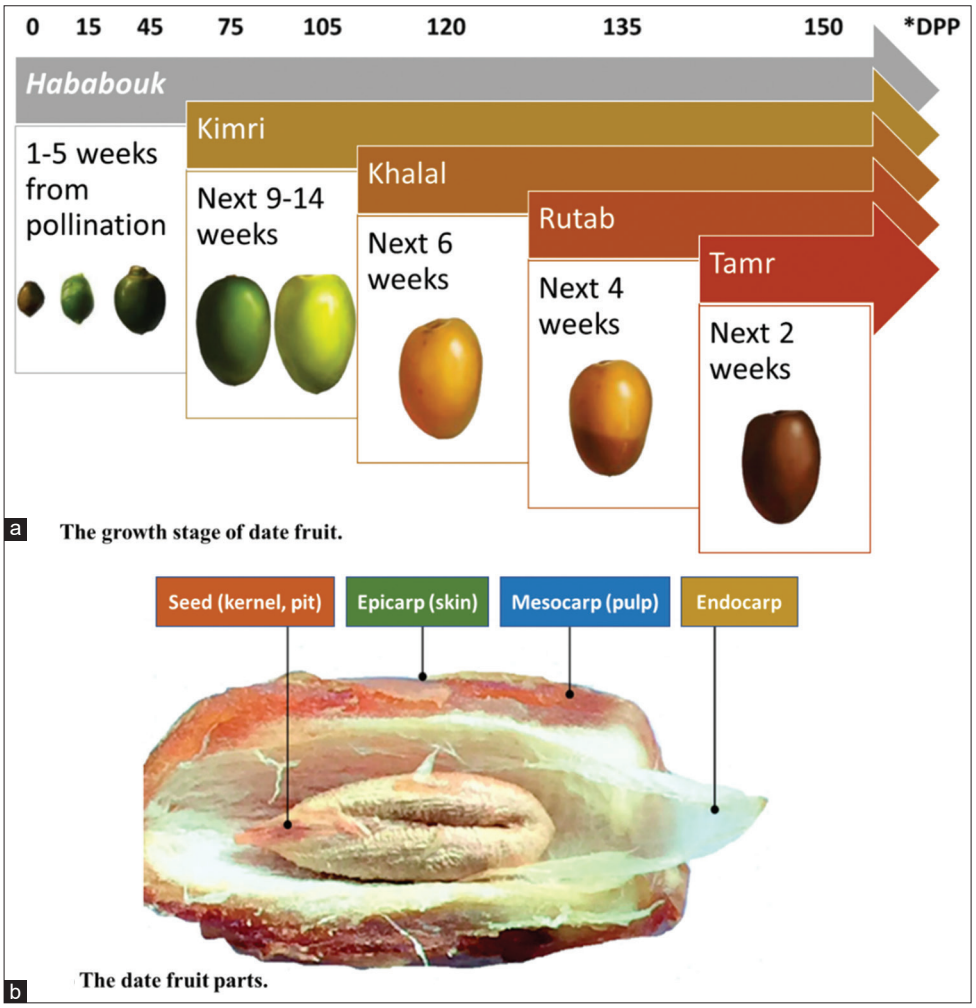

Fig 2. The growth stage of date fruit.

Tamr stage

It is the stage of full maturity or the final stage of maturity. The fruits of dates are fully ripened and take a black or brown color in Fig. 2a The texture is hard in dry dates, whereas soft in Rutab dates (Al udhaib, 2015). The fruit loss a large percentage of moisture, which leads to continued low weight and prevention of corruption or fermentation. The content of semi-dry and dry dates of sucrose is approximately 50%.

DATE FRUIT PARTS

The date fruit is composed of a pericarp, mesocarp, endocarp and one seed (also called the kernel, pit, or pyrene) (Fig. 2b). The mesocarp represents the largest part of the pulp of the fruit. It consists of enlarged chemical cells. It is divided into an outer layer and an inner layer. The inner mesocarp layer mediates between 3-10 layers of tannin cells. The seed has a ventral side characterized by a furrow of varying depth and width running along its length. The dorsal side of the seed is convex with a small shallow hole called the micropyle under which lies the embryo (Ghnimi et al., 2017).

THE QUALITY OF DATE FRUIT

Date fruit quality is determined based on four characteristics (Saleem, 2005):

1. The shape, color, and size, as well as the texture and taste of the fruit.
2. The percentage of moisture, sugars, and fiber in the fruit.
3. Fruit defects may be discoloration, deformation, shrinkage, cracking of the outer layer and sunburn.
4. Presence of insects, mold and decay, fertilizer residues or foreign matter.

The enzymatic content affects the quality of date fruits. There are three enzymes responsible for several processes, namely (Al-Shahib and Marshall, 2003):

1. The pectin esterase enzyme converts insoluble pectin into soluble pectin by a special mechanism.
2. Invertase, the enzyme that metabolizes sucrose into fructose and glucose.
3. The cellulase enzyme, which converts cellulose into simple compounds.

Some human errors in agricultural practices also affect the quality of dates, such as reducing the proportion of fertilizers, limited irrigation, not distributing trees at appropriate distances or not reducing the gathering of fruits, not controlling pests effectively and insufficient pollination, all of this leads to biological stress and abiotic and thus affect production.

DATE FRUIT AND BODY HEALTH

The value and importance of dates was mentioned in "the Holy Qur'an" in 20 verses of 17 Surahs of the Holy Qur'an, and it was also mentioned as one of the fruits of Paradise (The Qur'an). And in the honorable Sunnah of the Prophet, the Prophet Muhammad, peace be upon him, advised to eat the fruits of dates every morning, and indicated that it is a cure for more than one disease.

Everyone is now looking for healthy food options that maintain the quality of their health and provide them with energy and physical strength, such as vegetables and fruits, as well as natural healthy drinks that improve nutritional intake and increase life span. Also, people who follow a diet to lose weight should focus on choosing alternative foods with low calories, but High nutritional value (Mohammadi et al., 2018).

Dates are a delicious fruit with a sweet taste due to their high sugar content (70-80%). The sugars in dates are easily and quickly digested and metabolized, then, quickly enter the bloodstream. This makes them an immediate source of energy supply to the body. The quality of their carbohydrates results in a low glycaemic response (Uddin and Nuri, 2021). Date fruits are a basket full of different nutrients. Their different characteristics are due to their origin, environment, agriculture, growth, and types of fertilizer used. The compositional analysis showed that date seeds contain dietary fiber, which contributes to promoting the health of the intestines and the digestive system in general (Niazi et al., 2017). It is also rich in many minerals and in good proportions, such as potassium (255.43 mg/100 g of oil, which acts as an electrolyte inside the body, which is mainly linked to the metabolic of sodium, thus controlling nerves and heartbeat), magnesium (62.78), phosphorous (41.33) Calcium (48.56) mg/100 g of oil. Overall, they are mainly involved in the vital processes in the body and the maintenance of its balance (Nehdi et al., 2010).

It was pointed out the role of polyphenols, fibers, and micronutrients contained in dates in their ability to reduce the incidence of vascular diseases in humans when consuming whole dates or their extracts, as it modifies vascular health signals, such as the level of cholesterol and triglycerides in the blood, as well as indicators of oxidative stress (Al-Dashti et al., 2021). The antioxidant plant compounds present in dates are expected to activate enzymatic and non-enzymatic antioxidants. And that a diet

based on eating these natural plant materials reduces the risk of chronic diseases.

In date-producing countries, in addition to using dates to produce natural sweetening drinks and alcohol, it is used in traditional medicine as an alternative treatment in cases of stomach ulcers. This is believed to help protect the gastric mucosa from the damaging effect of gastric acid, which prevents the development of peptic ulcers, its used to enhance fertility, especially in women. Furthermore, it strengthens immunity. Vayalil (2002) also reported its role in antimicrobial resistance (Vayalil, 2002). Recently, has pointed out its role in controlling diabetes (Chaari et al., 2020).

From the pharmaceutical point of view, the fruits of dates provide an excellent source of medicines. They contain sterols, anthocyanins, flavonoids, carotene, and procyanidins, which are very useful phytochemical compounds. In addition to, their medicinal ability to fight cancer, antimicrobial, anti-mutagenic, and anti-inflammation of the stomach, liver, and kidneys, and play a major role in boosting the immune system, as summarized in Fig. 3 (Abd Elgadir, 2021). Date seed extracts have been used as a pharmaceutical product and have been reported as a nutritional supplement that supports the body's immune system (Mohammadi et al., 2018). In addition, the consumption of processed dates did not result in any toxicity, therefore it can be classified as a safe food.

The use of dates since ancient times in traditional medicine and is still among the treatment options for many people in various health conditions. It indicates a regular intake of dates fruit. Its inclusion in a healthy diet is a good option that reduces the risk of many diseases because it contains compounds that fight free radicals and antioxidants. The germs and microbes, thus maintaining public health (Al-Mssallem, 2020).

NUTRITIONAL COMPONENTS OF DATE FRUIT FLESH

Fruits of the date palm (Phoenix dactylifera L.) are rich in macronutrients and micronutrients, necessary to maintain public health or control certain diseases. In this section, the results of previous studies targeted the nutritional value of the fruits of some types of dates.

The whole plant in all its parts contains carbohydrates, alkaloids, steroids, tannins, proteins, fats, flavonoids, and vitamins. Its phenolic content indicates falconoid glycosides, flavones and cinnamic acids, which have been characterized using thin-layer chromatography (TLC) (Ahmed et al., 2016).

Moisture, ash, and sugar content

A study, that compared the chemical composition and nutritional value of ten types of dates in the Kingdom of Saudi Arabia, Including the Ajwa dates and the Sukkari

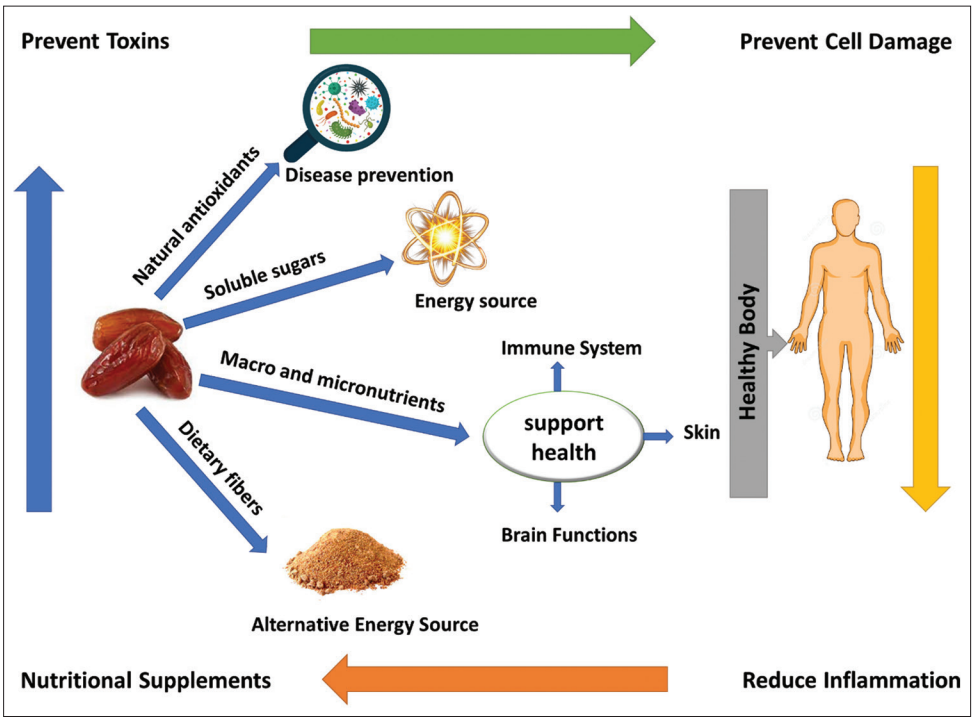

Fig 3. Role of dates in disease prevention via antioxidant, anti-microbial and anti-inflammatory activity.

dates (in the Tamer stage), were included as shown in Table 2. The average sugar content in Ajwa dates is (74.3%), equal to the value indicated by (Adwas et al., 2019) and glucose was the predominant one with an approximate percentage (51.3 ± 0.3), while fructose and sucrose showed concentrations (48.5%, and 3.2%), respectively. In addition, the content of moisture is (23%) and (3%) ash (Assirey, 2015, Batool et al., 2020). These percentages corresponded positively with the nutritional analysis of the date palms obtained by Khalid et al (Khalid et al., 2016). Sukari dates showed a high percentage of total sugar content (78.5%), here, it is divided into glucose (52%), fructose (48%), and sucrose (3%), respectively (Assirey, 2015). The sugar content was similar to what was reported in (Siddeeg et al., 2019). It was asymptotic to the value reported by Perveen and Bokahri, which is equal to 80%. while Ruthana cultivar showed a decrease in the concentration of total sugars with (24%), the lowest moisture content with (9.7%), and (6.7%) ash (Perveen and Bokahri, 2020). Therefore, it can be stored for a long duration since it has low moisture.

The high sugars content in date fruits indicates the possibility of adopting them as an immediate source of energy and enhancing mental activity. Sugar is the primary source of energy in the human body due to its rapid absorption and digestion. Thus, their role in reducing protein losses and promoting fat metabolism.

Mineral, protein, fat, and fiber content

Dates contribute to providing integrated nutritional content, as date fruits (date flesh) are a rich source of minerals, and the proportion of each mineral varies between dried and fresh dates according to the type of dates. Some types of dates contain 15 types of minerals, like calcium. magnesium, phosphorus, zinc, iron, and potassium. Metals are involved in many biological activities and act as catalysts in the reactions of metabolic processes in the human body. It is an essential part of the metabolism and absorption of all nutrients and the generation of nerve impulses (Ugulu et al., 2012).

The mineral content of Ruthana and Sukkari dates was analyzed using the ICP-OES technique (Perveen and Bokahri, 2020). It was noted that they contain varying proportions between small and large basic elements, as presented in Table 3. The Ruthana cultivar outperformed Sukkari in the content of each of calcium (921 mg, magnesium (851 mg), and phosphorous (727 mg)/kg, while the concentrations of calcium, magnesium, and phosphorous in the Sukkari date were (742, 731, 651 mg/kg respectively). Potassium content was highest in the two cultivars, Ruthana and Sukkari (7396 mg/kg in Ruthana, 6789 in Sukkari mg/kg). The high potassium content of Sukkari dates agreed with the results reported (Siddeeg et al., 2019)

The content of Ajwa dates contains calcium, magnesium and phosphorous (187, 150, 27 mg/100g dry weight, respectively. The potassium showed the highest concentration (476 mg/100g dry weight) (Assirey, 2015). These results are like other measures that indicated a higher concentration of potassium than other minerals in different

Table 2: The Moisture, ash, and sugar content of date fruit

Type of date	Total sugar content %	Glucose	Fructose %	Sucrose %	Moisture %	Ash %	Author
Ajwa	74.3	51.3	48.5	3.2	---	---	(Assirey, 2015)
	---	---	---	---	23	3	(Batool et al., 2020)
	75.2	---	---	---	22.9	3	(Adwas et al., 2019)
	---	54.5	52	---	22.8	3	(Khalid et al., 2016)
Ruthana	24.3	---	---	---	9.7	6.7	(Perveen and Bokahri, 2020)
	---	234 g/kg^{-1}	201 g/kg^{-1}	245 g/kg^{-1}	---	---	(El-Mergawi et al., 2019)
Sukkari	78.5	52.3	48.2	3.2	21	3.2	(Assirey, 2015)
	78.3	51.8	47.5	3	12.57	2.30	(Siddeeg et al., 2019)
	80.7	---	---	---	16	2.2	(Perveen and Bokahri, 2020)

Table 3: The Mineral content of date fruit, Protein, fat and fiber content

Type of date	Calcium mg/100g	Magnesium mg/100g	Potassium mg/100g	Phosphorus mg/100g	Author	Protein %	Fat %	Fiber %	Author
Ajwa	187	150	476	27	(Assirey, 2015)	2.77	0.26	2.43	(Arshad et al., 2019)
	189	148	480	---	(Batool et al., 2020)	2.9	0.49	2.03	(Batool et al., 2020)
	---	---	---	---		1.6	2.47	---	(Rahmani et al., 2014)
Ruthana	920.53 mg/kg	851.17	7396.7	726.9	(Perveen and Bokahri, 2020)	---	---	---	
Sukkari	742 mg/kg	731	6789	651	(Perveen and Bokahri, 2020)	3	0.65	3.15	(Siddeeg et al., 2019)
	186.5	148	620	26.5	(Siddeeg et al., 2019)	2.75	0.42	4.95	(Alghamdi et al., 2018)
	---	64.4	433.6	69.4	(Habib and Ibrahim, 2011)	5	0.32	---	(Alghamdi et al., 2018)

types of dates (Alghamdi et al., 2018). Dates are superior to different types of fruits in terms of mineral content, compared to the mango fruit, the calcium content of mango fruit pulp ranges between (7-16 mg/100g) and does not exceed its content of magnesium and phosphorous (19, and 18 mg/100g), respectively. The predominant mineral was potassium and its concentration reached 120 mg/100g, which is considered low compared to the potassium content of dates (Maldonado-Celis et al., 2019).

Date fruits contain good amounts of calcium, phosphorus, and magnesium. In addition to appropriate concentrations of iron, zinc, and selenium (Derouich et al., 2020). which support normal body functions, calcium and magnesium are necessary for bone health. The high content of potassium is suitable for high blood pressure cases, iron is an essential component of red blood cells. Moreover, these varieties of dates prove to have immense potential to be utilized as a therapeutic agent for curing mineral deficiency (Perveen and Bokahri, 2020).

Date flesh contains a good amount of protein and essential amino acids. This type of amino acid is not produced by the body but is obtained from food to promote overall health. For example, histidine and arginine are pivotal in the proper physiological functioning of the human body (Idowu et al., 2020). It also contains fats, which are the third primary source of energy for the human body after carbohydrates and proteins. They contribute to many vital processes and provide important fatty acids for mental and brain development. Dates also provide a good percentage of dietary fiber DF, which offers several health benefits such as lowering blood cholesterol by reducing low-density lipoprotein, Moreover, it reduces the risk of obesity, hemorrhoidal diseases and enhances bowel health (Maqsood et al., 2020).

A study on the nutritional content and chemical composition of Sukkari date indicated that they contain almost varying proportions of crude protein, crude fat, and fibers, the fat content (0.42-0.65 %), the protein content ranged from (2.75-5 %) and between (3-5 %) of fibers, as shown in Table 3 (Alghamdi et al., 2018, Siddeeg et al., 2019, Trabzuni et al., 2014). Whereas Ajwa dates showed lower protein and fiber content, but higher fat content. the protein content ranging between (1.6 - 2.8 %), fiber content (2%), and fat content between (0.26- 2.47%), according to (Batool et al., 2020), while the content of these compounds in Ruthana dates has not been reported.

The nutritional value and contents of protein and fat are not limited to the flesh of the dates only, the seeds also contain a good amount and may exceed flesh in some varieties, due to a decent fat content and calories. The fruits of dates help with satiety, therefore can be considered as a complementary or alternative food in cases of dieting to lose weight. The content of dates on fiber complements its nutritional value as it cannot be dispensed within the diet. Fiber promotes digestive health and reduces Cholesterol in the blood protecting against coronary heart disease or high blood pressure. The content of the seeds with significant values of protein, fat, and fiber and good proportions of oleic acid (Besbes et al., 2004) enhances the possibility of extracting the seed oil as it will provide multiple benefits and good nutritional value (Metoui et al., 2019) or use the seeds in different industries such as cosmetic products.

Phytochemical compounds and antioxidant activity

Polyphenols compounds are natural metabolites that have many medicinal benefits, chemically defined as organic compounds containing hydroxylated aromatic rings. They contain one or more hydroxyl substituents (Tsao, 2010). Their nature, formulation, and distribution in date palm fruit are dependent on date palm variety, growing conditions, and extraction procedures. Phenolic and Flavonoid compounds are powerful antioxidants that may help reduce inflammation and have been studied for their potential to reduce the risk of heart disease, aging,

mutagenesis, Alzheimer's disease, and certain types of cancer with controlling many health setbacks (Bakhtiari et al., 2017).

Among the 17 types of fresh date, fruits were evaluated for their contents of sugars and phenols and their association with antioxidant activity. Ajwa date cultivar showed the second-highest phenol content (3.82 g kg−1 gallic acid), while both Sukkari and Ruthana cultivars show less content compared to Ajwa dates phenol content (2.48 g kg−1/2.67 g kg−1 gallic acid, respectively), as shown in Table 4 (El-Mergawi et al., 2019). However, these results indicate that the content of date fruits of phenols may exceed other types of fruits, for example, strawberry fruits have been indicated to contain (0.04– 0.33 g kg−1 FW), of phenols, as well as berries (0.06–2.28 g kg−1 FW), in addition to apples and tomatoes with Phenol concentration (0.01–0.48, 0.01–0.30 g kg−1 FW) respectively, according to (Proteggente et al., 2002).

Moreover Wu et al. (2004) reported that the phenolic content of different varieties of dates exceeded that of many types of fruits consumed in the United States (Wu et al., 2004). These ingredients include phenolic acids (ferulic acid, coumaric acid, and sinapic acids), as well as flavonoids (apigenin, luteolin, and quercetin). The flavonoid content of Sukari dates was (4.86 mg QE/100g extract), and (172.1mg/100g) for Ajwa dates as shown in Table 4. (Batool et al., 2020). But there is no indication of the flavonoid content of Ruthana.

In the same context, the antioxidant activity showed significant differences among the tested date cultivars, ranging between (4.12 ± 0.18 of Sukari, 3.37 ± 0.22 of Ruthana and 6.14 ± 0.22 μmol Trolox g−1 of Ajwa) as assayed by the DPPH method, while in the FRAP method, the varieties Sukari, Ruthana and Ajwa showed the highest values comparing DPPH, which reached (10.89 ± 0.37, 10.50 ± 0.34, and 14.45 ± 0.23 μmol Trolox g−1, respectively), as shown in Table 4.(El-Mergawi et al., 2019).

The antioxidant effect of the three types of dates is consistent with the results reported by (Zhang et al., 2017) in a study comparing the antioxidant activity of aqueous and methanolic extracts for 30 varieties of dates, using the MTT test, which detects the ability of compounds to scavenge or reduce free radicals, and the LPO test, which targets the detection of compounds. responsible for this activity. The study concluded that the methanolic extracts of dates recorded higher antioxidant activity than the aqueous extracts in the MTT test at 250 μg/mL. Luban, Ruthana and Khashram dates had the highest antioxidant activity on a par with the absorbance shown by the positive controls (Table 4). The absorbance of Ruthana and Luban reached 0.45 and Khashram 0.40 at 570 nm. While the absorbance of aqueous extracts of dates did not exceed 0.16 at the same wavelength.

In the LPO assay shown in Table 4, water, and methanol extracts of all cultivars at 100 μg/mL showed a good inhibition activity (50-67% and 58-82%). Among the water extracts, Ajwa, Mabroom and Hilali showed the highest LPO inhibition by about 65%, Ruthana and Sukari showed (63%, 58%, respectively). and methanolic extract of Mutwah dates showed the highest LPO inhibitory activity, about 82%, and was similar in activity with respect to the positive controls used in the assay. Ruthana also showed a high activity that exceeded 70%, followed by Ajwa with an activity rate of 62%, then Sukari dates with 58% (Zhang et al., 2017).

The antioxidant activity is due to the phenols and flavonoids in dates, it is expected that could protect against chronic diseases and combat degenerative diseases that are associated with free radicals and oxidation, such as heart disease and cancer as mentioned, which are common diseases worldwide. Several solutions must be found to reduce them. The antioxidant metabolites in date fruits help to establish cellular homeostasis and thus give a beneficial effect across biological systems (Hafzan et al., 2017). As the antioxidant activity does not mean fighting free radicals only, it also enters into the action of antioxidant enzymes and regulation of the detoxification mechanism, in addition to regulating the signals of redox processes as well as gene expression.

Table 4: The antioxidant activity of date fruit with Phenolic and flavonoid content

Assay	Ajwa	Ruthana	Sukari	Author
DPPH (μmol Trolox g−1)	6.14 ± 0.22	3.37 ± 0.22	4.12 ± 0.18	(El-Mergawi et al., 2019).
FRAP (μmol Trolox g−1)	14.45 ± 0.23	10.50 ± 0.34	10.89 ± 0.37	
MTT, water extract (at 570 nm)	0.16	0.13	0.11	(Zhang et al., 2017).
MTT, methanolic extract (at 570 nm)	0.32	0.45	0.22	
LPO, water extract	65%	63%,	58%	
LPO, methanolic extract	62%	70%	58%	
Total phenols g kg−1 gallic acid	3.82	2.67	2.48	(El-Mergawi et al., 2019).
Total flavonoid mg QE/100g extract	172.07 ± 0.02	---	4.86 ± 0.07	(Batool et al., 2020). (Trabzuni et al., 2014).

The basic ingredients of dates around the world, in general, are similar, but the difference in the proportions of the contents remains, and this is due to several factors (soil, fertilizer, variety, etc.). The components of Egyptian dates were referred to a thorough analysis of vitamins such as vitamin B1, B2, and vitamin A. The moisture content is (13.8%), and (86.50%) solids, as well as (2.13 and 5.20%) fibers and ash, respectively, and the concentration of carbohydrates reaches (73%), while the percentage of fat and protein is equal to 3% (Khan et al., 2021).

The energy values in date fruit

Date fruit provides a high value of energy, and this is due to its high content of sugars, and the percentage of energy in dates ranges between 288 kcal/100 g, to 358 kcal/100 g. This percentage means that consuming 100 grams of date fruit provides between 10-18% of the energy needs of adults daily (Al-Farsi et al., 2005).

HEALTH BENEFITS

Date fruit contains a wide range of phytochemical compounds that offer many health benefits; anti-bacterial, anti-inflammatory, cytotoxic activity, and antidiabetic properties, which will be discussed in this section.

Anti-bacterial activity

Infectious diseases cause a high rate of health problems in developing countries. Many plant species provide a good source of antimicrobials, approximately 20% of plants have been studied and tested biologically and therapeutically. Many antibiotics are obtained from a natural or semi-synthetic origin (Negi et al., 2003).However, although hundreds of plants or herbal species have been studied for their antimicrobial properties, many of them have not been adequately evaluated.

Eid et al (2014) indicated in a study conducted about the beneficial bacteria changes that occur in the intestine when taking whole date fruit extract (the digested Ajwa date extract; DDE) and the extract high in polyphenols (date polyphenol extract; DPE) (Eid et al., 2014). The results were taken based on fecal cultures regulated by pH and mimicking the human large intestine. The Fluorescence microscopic count indicated a clear increase in bifidobacteria growth in response to both extracts, and the increase in bacterial growth within 24 hours was greater for those who took whole date extract (DDE) compared to those who took the extract rich in polyphenols (DPE). The production of flavonoids aglycones (myricetin, luteolin, quercetin and apigenin) was also observed in less than an hour, due to bacterial metabolism. These results provide evidence that both DDE and DPE extracts derived from Ajwa dates can significantly increase the growth of beneficial bacteria (Eid et al., 2014)as well as their ability to inhibit pathogens and raise the production of lactate and acetate (Al udhaib, 2015) which contributes to the promotion of colon health.

On the other hand, a study conducted by (Hussain Mallhi et al., 2014) included testing the effect of extracts (water, methanol, and acetone) from Ajwa date fruit, seeds, bark and leaves on *(S. Aureus, S. Pyogenes)* strain of Gram-positive bacteria and *(E. Coli, P. Aeruginosa)* of strains of Gram-negative bacteria. The study was based on disc diffusion in inhibition, the results indicated that all parts of the plant show anti-bacterial activity, fruits and leaves showed the highest anti-bacterial values from seeds and bark, and the aqueous extract was the least active, due to the ability of methanol and acetone to dissolve a large group of Botanical ingredients unlike water's ability to. While the antibacterial activity is attributed to some compounds such as alkaloids, flavonoids, and tannins which have been reported to have antibacterial properties phenols (Hussain Mallhi et al., 2014).

The role of the leaves of the Sukari date palm was previously indicated in the fight against bacteria and microbes, against Gram-positive bacterial strains *(Staphylococcus aureus Staphylococcus epidermidis, Enterococcus faecalis)* and Gram-negative bacterial strains *(Klebsiella pneumoniae and Escherichia coli)* (Abdallah et al., 2017). These results agree with another study in which the antibacterial activity of acetone, methanol, and water extracts from leaves and pits of Ruthana, Sukkari and Barhi dates was evaluated, based on MIC measurement. The three have good antibacterial activity against Bacillus subtilis, Escherichia coli, Pseudomonas aeruginosa, Shigella Flexner, Staphylococcus aureus, and Streptococcus pyogenes. While the activity of aqueous extracts was low, compared with doxycyline (standard positive control. *S. pyogenes* was the most sensitive of all extracts. The methanolic extract of Barhi date leaves and pits showed the highest effect compared to the aqueous and acetone extract, with Inhibition zone 22.7 mm on *S. pyogenes* strain of leaf extract and 32.0 mm of pit extract. While the methanol leaf extracts showed the highest activity on *B. subtilis* strain of Sukkari dates and acetone leaf extract showed the highest effect on the *S. pyogenes* strain with Inhibition zone 20.3 mm for both extracts, and 33.0 mm of ethanolic pit extract on *S. pyogenes*. The extracts of methanol and acetone from leaves and pits of Ruthana dates gave equal Inhibition zone values on the *S. pyogenes* strain, it was 20 mm from leaf extracts and 29.3 mm from pit extracts. (Perveen et al., 2012). Earlier it was mentioned the ability of pits, fruits, and leaves of dates against Gram-positive/ Gram-negative bacteria (Ammar et al., 2009). Moreover, (Abuharfeil et al., 1999) reported the ability of date fruit

extracts to neutralize the hemolytic activity of *Streptococcus exotoxins*, as low concentrations provided an inhibition rate of more than 95%. The whole date plant contains flavonoids, tannins and vitamins, and the antimicrobial effect is since it contains antioxidant components (Cutter, 2000, Perveen and Bokahri, 2020). However, there is still a need to know the potential mechanisms that give these activities to be used as antibacterial and antimicrobial agents.

Anti-inflammatory activity

A balanced diet that includes all nutrients and is rich in vegetables, fruits, and natural herbs, provides a large proportion of vitamins, minerals, and various beneficial compounds, all of which play an important role in reducing infections and thus preventing multiple related diseases. Inflammation is scientifically defined as the body's defense system that works based on a consistent response from the body's tissues to an external challenge or any abnormal chondral injury (the response of the host against microbial or chemical factors); but it can become harmful if dysregulated. The mechanisms of inflammation include activation both of macrophages and T-lymphocytes, in addition, to release of pro-inflammatory mediators such as tumor necrosis factors- alpha (TNF-α), interleukin-1 (IL-1), nitric oxide (NO), and prostaglandin-E2 (PGE2)] (Lin and Karin, 2007). The presence of inflammation may lead to several diseases, including chronic diseases, such as arthritis, autoimmune diseases such as thyroiditis, as well as allergies and metabolic syndrome, and perhaps more serious diseases such as cancers.

The anti-inflammatory activity of more than one part of the date palm tree has been researched, based on its use in traditional medicine to treat various infections such as gastroenteritis and bronchitis. It has been combined with paracetamol and ibuprofen as pain relievers (Taleb et al., 2016).

In vitro, A study was conducted on mice with Alzheimer's, who were given long-term dietary supplements of 2 and 4% of date fruit extracts. The mice were fed these supplements for 14 months, and the results were compared to mice that were not given the supplement. Reduced levels of oxidative stress factors were observed in mice fed with date extract supplements (such as lipid peroxidation and protein carbonyl), as well as restoration of antioxidant stress enzymes.(Subash et al., 2014)

El Hilaly et al (2018) researched the anti-inflammatory effect of the fruits of six types of dates in Morocco (Boufgous, Bouskri, Bousrdon, Bousthammi, Jihl, and Majhoul), and it has been shown that the phenolic properties that date fruits contain have a remarkable effect in suppressing inflammation and edema of rats that cause it. Injections of carrageenan and Bousrdon and Jihl were the most effective. Caffeic acids, Ferulic and Gallic were the most active polyphenols in preventing damage to the membrane of red blood cells. These types have shown a clear effect in inhibiting protein denaturation (employing bovine serum albumin) (El Hilaly et al., 2018).

In another study, the rate of inhibition of COX-1 and COX-2 enzymes was investigated to estimate the anti-inflammatory activity of the extracts of Ruthana, Ajwa and Sukkari dates. Was the ability to inhibit these enzymes by 35-36% for Ruthana dates, 35-37% for Sukkari dates, 32-40% for Ajwa dates, at concentration 100 lg/ml (Zhang et al., 2017). Cyclooxygenase COX-1 and COX-2 stimulate the production of levuloglandins and prostaglandins, and prostaglandins are mediators whose activity enters physiological and pathological processes that interact reversibly with membrane-coupled receptors G. levuloglandins. The importance of COX enzymes is to prevent these interactions with NSAIDs. Thus, eliminating inflammatory problems (Fitzpatrick, 2004).

Cytotoxic activity

Cancer causes huge health and financial problem in the world. The number of deaths due to cancer reached an estimated 1.8 million deaths in the United States of America alone in 2020 according to (Siegel et al., 2020). A recent study estimated that the most common type of cancer in 2040 is breast cancer, followed by skin cancer, with lung cancer ranked third (Rahib et al., 2021). The emergence of cancer is caused by many factors, which in turn lead to changing the normal mechanisms of gene action and thus the abnormal reproduction of cancer cells. Preventive, chemotherapeutic, and radiological factors are relied upon to treat cancer, but the negative consequences lie in the side effects and complications resulting from these treatment methods. Phytochemicals such as polyphenols play an important role and may be an alternative in the treatment of various diseases, including cancers, without side effects or high financial cost.

Date fruit provides an effective anti-cancer effect against various types of cancer, due to its high content of polyphenols and flavonoids (El-Far et al., 2019), In turn, as antioxidants, they work to reduce oxidative stress, as the emergence of infections and cancers depends as a reaction related to the presence of reactive oxygen species and the production of free radicals (ROS) (Jakubowska et al., 2016). But the exact mechanism of action of the components of date fruits in the prevention of tumors is still unclear.

Abd Elgadir (2021) indicated the effect of ethyl acetate compounds from Ajwa dates fruit on the prostate cancer cell line, when the prostate cancer cell line (PC3) was

treated with acetate and showed strong efficacy at low concentrations (0.2-0.6 mg/ml), its activity was described Inhibition of oxidative stress and loss of mitochondrial membrane potential in treated cells, indicating the occurrence of apoptosis (Abd Elgadir, 2021). These results agree with those indicated previously by (Mirza et al., 2018). In the same context, it was previously mentioned that Khalas date extracts have a significant effect in controlling or reducing the activity of pancreatic stellate cells, the formation of lymphocytes, and the decrease in cellular proliferation. The ethanolic extract of Khalas date fruit also showed a clear effect in stimulating apoptosis of human hepatocellular carcinoma (HCC) cell lines based on chromatographic analysis, while this extract did not show any negative effect on normal human cells Vero, which enhances its nomination as a safe and natural extract that can be introduced. in the treatment of liver cancer (Al Alawi et al., 2020).

Despite these, it's based on the microscopic examination and observation of the phases and morphological changes of human breast adenocarcinoma (MCF) cell line such as cell shrinkage or fragmentation and emptying, the results of the MTT-test (2-(4,5-dimethylthiazol-2-yl)-2,5-diphenyltetrazolium bromide) showed the ability of the methanol extract Ajwa dates can induce programmed death, stop the cell cycle in the "s" phase, and decrease the mitochondrial membrane potential in 24 hours (Khan et al., 2016). In addition, it was reported its role in inhibiting the growth of Caco-2 cells after 24 hours of treatment in Ajwa date extract, and it showed positive results in preventing cell growth and proliferation (Eid et al., 2014), and inhibiting the growth of HepG2 cells of the human hepatocellular carcinoma (HCC) line. This activity was attributed to the Ajwa date pulp containing the active compound -D-glucan, which caused apoptosis (Varijakzhan et al., 2020). Indicated in these results is the role of date fruits in promoting colon health and preventing or limiting the spread of colorectal cancer.

Depending on the ability of dates to inhibit free radicals, and anti-inflammatory activity by inhibiting COX-2 enzyme, it was reported (Zhang et al., 2017) about its role also in the toxicity of cancer cell lines AGS (gastric), LNCaP (prostate), HCT-116 (colon).), MCF-7 (breast) and NCI-H460 (lung) In a study that included extracts from different date fruits, all studied extracts, including methanol extracts from Ruthana and Sukkari dates, showed an average inhibitory effect ranging between 20-25% on human cancer lines in Colon, breast, stomach, and lung, this study concluded that date fruits have better antioxidant and anti-inflammatory properties compared the effect on cytotoxicity on the studied cancer cell lines.

These results are consistent with the role of Ajwa date extracts in inhibiting gastric marginal cell proliferation and toxicity on lung, breast, prostate, and colon cancer cell lines (Zhang et al., 2013). The results were like the activity of pomegranate fruit extracts on the studied cell lines, and some citrus fruits because they contain polyphenol compounds that play a key role in this activity (Al-Mssallem, 2020).

Antidiabetic properties

Diabetes is a global disease that develops because of chronic disturbances in the metabolism of carbohydrates, fats, and proteins. As a result, insulin sensitivity or reduced secretion occurs, and consequently, poor control of blood glucose levels (Mia et al., 2020). The effects of diabetes develop to damage several body organs such as the heart, liver, kidneys, and retina of the eye, as well as peripheral nerves.

The drugs currently used in the management of diabetes are not without side effects, such as disrupting the metabolism and disrupting the genetic pathway (Maqsood et al., 2020). The American Diabetes Association (2014) indicated that the approach or mechanism to be followed in managing diabetes depends on regulating blood glucose levels to be within the normal range. Accordingly, food choices that affect the increase in blood sugar after eating a meal are very important to control diabetes complications. According to European guidelines based on the glycemic index, which states that eating foods rich in carbohydrates with low glycemic index are acceptable when they are taken with appropriate foods and help improve blood sugar levels like date fruits. Moreover, it reduces the risk of many sequential diseases such as coronary heart disease, breast cancer and gallbladder disease (Mann et al., 2004). and control of hyperlipidemia by reducing the proportion of fats in the plasma (Echegaray et al., 2020).

Meanwhile, the biologically active compounds in dates (polyphenols, saponins, and steroids) can provide activity in protecting or controlling diabetes. Some studies have demonstrated their ability to control blood glucose in diabetic mice (Zhang et al., 2017) as well as its role in reducing oxidative stress in maintaining the proper functioning of the liver and kidneys. This activity was attributed to the ability of polyphenols to retard ά-glucosidase and thus control glucose entering the small intestine and kidneys (Hasan and Mohieldein, 2016). It has also been suggested that anthocyanins and anthocyanins contribute to insulin-like activity (Anderson et al., 2004).

A study conducted on 17 types of dates produced by the Kingdom of Saudi Arabia, including (Medjool, Ruthana,

Ajwah, Khudri, and Sukkari), revealed that the types of dates included in the study had low to medium GI values, which means that they can be adopted as a food source for carbohydrates for both people, healthy and diabetic patients (AlGeffari et al., 2016). Another study to measure blood sugar levels (glucose challenge and Alloxan-induced hyperglycemia) conducted using experimental animals indicated the role of Aseel date extract that was provided as an oral suspension to experimental mice at two doses (300 and 600 mg/kg) and compared it to the standard drug (glibenclamide 2.5 mg/kg). Where a dose (300 mg/kg) showed a significant decrease in the level of glucose in the blood, depending on the concentration (Ahmed et al., 2017). These results agree with those mentioned by (Jarrar et al., 2019) in those dates low GI index. Based on the biochemical analysis to test the effectiveness of date seed extract in controlling blood glucose in experimental mice with type 1 diabetes, it indicated a significant decrease in the average blood sugar in diabetic mice treated with insulin and date seed extract with an increase in the average level of C-peptide in the blood. The increase in endogenous insulin secretion in mice treated with date seed extract is due to its role in lowering blood sugar levels (El Fouhil et al., 2013). Despite this, many laboratories and clinical studies are required to evaluate the effectiveness of date fruits or seeds in controlling blood glucose levels.

The mechanism of this activity is still not completely clear, which is believed to be due to a decrease in glucose absorption in the intestine and the maintenance of its concentration in the blood due to the rise in insulin and the activation of glycogen synthesis by derived diosmetin glycosides.

The role of date fruit in the health of the nervous system

A study proved the role of Ajwa, Safai, and Sukkari date in relieving central nervous system disorders and helping to sleep for a longer period, and the positive neuropharmacological effect on pentobarbitone-induced sleep was observed, the three extracts helped reduce motor activity and prolong sleep period for experimental mice, and in the test of anti-etiological activity By means of the acetic acid-induced meta-test and the hot plate test, the studied extracts reduced the acetic acid-induced torsion as well as delayed response time in the hot plate test (Sheikh et al., 2016). It was also indicated for its effectiveness in treating anxiety, psychosis and cognitive impairment, and in the treatment of headaches and migraines (Shanmugapriya and Patwardhan, 2012). Dates are an essential ingredient in the patented Chinese medicine for the treatment of sleep disorders.

Functional food applications of date palm

Based on the variety of date fruit components and their health benefits, several studies have targeted different applications of dates, as roasting date fruit pits and producing caffeine-free coffee thus avoiding some of the symptoms caused by caffeine, such as stress, this mechanism is used in Arab countries as well as people who seek to quit smoking. This product has been launched in the market as an alternative to coffee powder.

As indicated by (Mrabet et al., 2017) in a study on the Soluble Dietary Fiber (SDF) that dates contain it, provides an excellent source of health-promoting by converting them into enzyme-modified products that provide antioxidant and digestive benefits. The date syrup was used to produce a special type of yogurt by adding or reconstituting skim milk powder with different concentrations of date palm syrup, and the product was described as sweeter and richer in antioxidants (he total phenolic contents), and folic acid compared to regular yogurt, thus improving the health beneficial properties of the yogurt. In addition, date powder is used in baked products, It has also been reported that sucrose can be replaced by date fruits in baked goods, which provides good nutritional content for bread while reducing harmful effects on the properties of the product. Cakes fortified with 2.5 and 5% of date fruit fiber carry higher nutritional quality (Mrabet et al., 2017). the seed powder raises the nutritional value of Arabic bread by fortifying it with dietary fiber (Al-Dalalia et al., 2018). Also, mixing a solution of date seeds (DSFH) at a percentage (2.5%) with flour for cake production increases the total percentage of ash and dietary fiber. One of the products of chemical modification of date seeds is polyol. These compounds contain a functional hydroxyl group that enters organic reactions and is added to foods because they contain fewer calories than processed sugars. On the other hand, date jam can be manufactured with high nutritional and commercial value. It has been compared to quince jam, and both gave similar acceptance to consumers, this encourages the manufacturers to learn more about the properties of this product as it is a potential and positive alternative to traditional fruit jams. In another study, it was suggested that date seed oil as a by-product helps to stabilize the protection of edible oils from oxidation, due to its high content of polyphenols. She also indicated that the date seed oil has a sharp yellow color compared to other vegetable oils, and this gives it the advantage of protection from ultraviolet rays and the protection of skin cells, based on that it was nominated for use in the production of cosmetics (El-Massry et al., 2019). Vinegar is also produced by the alcoholic fermentation of a sugary date solution. (Sarma et al., 2022) also indicated that the date fruit sap is a very nutritious drink, as it removes toxins from the body, as it is rich in many nutrients.

Recently, energy bars for athletes have been manufactured and produced, where athletes around the world eat Nutri

bar, which is a food material in the form of fingers with a mixture of concentrated nutrients to provide vitality and physical and mental energy, and its composition is rich in carbohydrates and medium protein concentration. Produced with a blend of soft, pitted dates with secondary ingredients such as (gluten-free oats, dried whole grains), a source of protein from whey or dry milk, and other nutrient-rich items. This product is ready to eat as well as can be easily stored and provides a balanced nutritional content that meets the body's need for nutrients It is large and small and contributes to a balanced metabolism and provides nutritional and therapeutic value at the same time, thus maintaining the proper functioning of the human body (Tang et al., 2013).

Since dates are a good source of vitamins, as the concentration of ascorbic acid is (2.4 - 17.5 mg/100 g), (0.13 - 17.5 mg/100 g) of riboflavin, (0.08 - 0.13 mg/100 g) of thiamine (Chaira et al., 2007) capsules have been manufactured. Dates as a pharmaceutical product used as a food supplement provide healthy support to the body.

Traditionally, in the countries of the Middle East, a basic product is not dispensed with on occasions and holidays, which is the Ma'amoul. It is considered a dough stuffed with dates and walnuts and offers a delicious taste. It is formed in wooden molds to take certain shapes.

DISCUSSION

The nutritional and health value of date fruits was studied, by comparing three different types of dates produced by the Kingdom of Saudi Arabia, namely, Sukkari, Ruthana and Ajwa. The health benefits offered by this fruit were discussed. It was pointed out that the three types of date fruit with their various parts is a rich source of antioxidants such as polyphenol (phenols and flavonoids) compounds, which provide a positive effect in preventing free radicals and thus protection from the occurrence of oxidative stress, which in turn causes many diseases. This suggests, the possibility of using date fruits as an antioxidant, infections, cancers, or controlling blood glucose levels, coronary heart disease, and obesity, As shown by previous studies. The study also concluded its role in inhibiting bacterial proliferation on gram-positive and gram-negative bacteria strains.

In addition to these benefits, dates offer a suggested functional remedy. The sugar content of dates fruit is an excellent instant source of energy in cases of low blood glucose levels or to improve mental focus. It is also suggested that sugar extracted from dates be used as an alternative to processed sugars. On the other hand, its high content of Dietary fiber enhances the possibility of using whole dates fruit or extracts added to functional foods, in turn raising the quality of food to health and enhancing the health of the intestines and colon. Furthermore, they contain good proportions of minerals that every cell of the human body needs, to maintain cellular functioning and biochemical reactions and maintain the proper functioning of the body.

The prospect of manufacturing new health products from the by-products of date fruits, which are seeds, was also mentioned, as it was reported that they contain excellent values of dietary fiber and phenolic compounds. It can be re-manufactured in the form of products such as coffee, jams, or oil extracted, or added to raise the nutritional value of baked goods.

CONCLUSION

Dates are a good source of many nutrients essential for human health, such as amino acids, essential fatty acids, minerals, and fiber, as well as compounds that provide antioxidant activity by fighting free radicals such as phenols, flavonoids, and carotenoids, which protect against inflammatory diseases and cancers. These properties give date fruits a potential advantage for their use in functional foods, but there is still a need to research the biological mechanisms of action of these compounds and how to use them in the development of health food industries as well as in the pharmaceutical field. Based on the literature and previous research, the scientific community has begun to realize the nutritional value of dates fruit due to its richness in various nutrients, which provides multiple health benefits to the human body, as well as increases the possibility of its use in all conditions compared to other types of fruits, due to it can be stored for several months, and it is cheap that poor communities can buy and exploit its benefits, as well as can be eaten by young and old. Since it is a food that is very rich in energy sources and essential nutrients that the human body needs for growth and disease prevention, the fruits of dates must be exploited and included in the list of research and food and pharmaceutical industries, so researchers are looking to isolate effective phytochemical compounds and further investigate their mechanism of action and the biological effect they play. Date fruit is a suggestion worth researching and exploring.

AUTHORS' CONTRIBUTION

Nosiba A. Alsarayrah (NAA), Fouza K. ALEnazi (FKA), and Naif D. Alenzi (NDA) contribute to guttering articles and prepared the pre-manuscript. Eshaifol A. Omar (EAO), Saud M. Alsanad (SMA), Hasni Arsad (HA) and Mubark M.

Abudahash (MMA) contributed to the supervision of the work and finalizing the paper writing. All authors discussed the key findings and contributed to the final manuscript.

CONFLICTS OF INTEREST

The authors declare that there is no conflict of interest. Our initiations had no role in the design of the study; in the collection, analyses, or interpretation of data; in the writing of the manuscript; or in the decision to publish the key findings.

REFERENCES

Abdallah, E. M., K. H. Musa, K. A. Qureshi and A. M. Sadeek. 2017. Antimicrobial activity and antioxidant potential of the methanolic leaf extracts of three cultivars of date palm trees (*Phoenix dactylifera*) from Saudi Arabia. Med. Sci. 6: 614-619.

Abuharfeil, N. M., S. E. Sukhon, Y. Msameh and A. K. J. Sallal. 1999. Effect of date fruits, *Phoenix dactyliferia* L., on the hemolytic activity of Streptolysin O. Pharm. Biol. 37: 335-339.

Adwas, A. A., A. Elsayed, A. Azab and F. Quwaydir. 2019. Oxidative stress and antioxidant mechanisms in human body. J. Appl. Biotechnol. Bioeng. 6: 43.

Ahmed, A., N. Bano and M. Tayyab. 2016. Phytochemical and therapeutic evaluation of date (*Phoenix dactylifera*). A review. J. Pharm. Altern. Med. 9: 11-17.

Ahmed, S., R. A. Khan, S. Jamil and S. Afroz. 2017. Antidiabetic effects of native date fruit Aseel (*Phoenix dactylifera* L.) in normal and hyperglycemic rats. Pak. J. Pharm. Sci. 30: 1797-1802.

Al Alawi, R., M. S. S. Alhamdani, J. D. Hoheisel and Y. Baqi. 2020. Antifibrotic and tumor microenvironment modulating effect of date palm fruit (*Phoenix dactylifera* L.) extracts in pancreatic cancer. Biomed. Pharmacother. 121: 109522.

Al Udhaib, R. 2015. Solvent Extraction of Antioxidants, Phenols and Flavonoids from Saudi Arabia Dates. Master of Applied Science, Dalhousie University, Canada.

Al-Alawi, R. A., J. H. Al-Mashiqri, J. S. Al-Nadabi, B. I. Al-Shihi and Y. Baqi. 2017. Date palm tree (*Phoenix dactylifera* L.): Natural products and therapeutic options. Front. Plant Sci. 8: 845.

Al-Dalalia, S., F. Zhenga, S. Aleidc, M. Abu-Ghoushd, M. Samhourie and A. F. Ammar. 2018. Effect of dietary fibers from mango peels and date seeds on physicochemical properties and bread quality of Arabic bread. Int. J. Modern Res. Eng. Manag. 1: 10-24.

Al-Dashti, Y. A., R. R. Holt, C. L. Keen and R. M. Hackman. 2021. Date palm fruit (*Phoenix dactylifera*): Effects on vascular health and future research directions. Int. J. Mol. Sci. 22: 4665.

Al-Farsi, M., C. Alasalvar, A. Morris, M. Baron and F. Shahidi. 2005. Comparison of antioxidant activity, anthocyanins, carotenoids, and phenolics of three native fresh and sun-dried date (*Phoenix dactylifera* L.) varieties grown in Oman. J. Agric. Food Chem. 53: 7592-7599.

Algeffari, M. A., E. S. Almogbel, H. T. Alhomaidan, R. El-Mergawi and I. A. Barrimah. 2016. Glycemic indices, glycemic load and glycemic response for seventeen varieties of dates grown in Saudi Arabia. Ann. Saudi Med. 36: 397-403.

Alghamdi, A. A., A. M. Awadelkarem, A. Hossain, N. A. Ibrahim, M. Fawzi and S. A. Ashraf. 2018. Nutritional assessment of different date fruits (*Phoenix dactylifera* L.) varieties cultivated in Hail province, Saudi Arabia. Biosci. Biotechnol. Res. Commun. 11: 263-269.

Al-Khayri, J. M., S. M. Jainand D. V. Johnson. 2015. Date Palm Genetic Resources and Utilization, Springer, Berlin.

Al-Mssallem, M. Q. 2020. The role of date palm fruit in improving human health. J. Clin. Diagn. Res. 14: OE01-OE06.

Al-Shahib, W. and R. J. Marshall. 2003. The fruit of the date palm: Its possible use as the best food for the future? Int. J. Food Sci. Nutr. 54: 247-259.

Ammar, N. M., T. Lamia, E. Abou, H. Nabil, M. Lalita and J. Tom. 2009. Flavonoid Constituents and Antimicrobial Activity of Date (*Phoenix dactylifera* L.) Seeds Growing in Egypt. In: Proceedings of 4th Conference on Research and Development of Pharmaceutical Industries (Current Challenges). Medicinal and Aromatic Plant Science and Biotechnology, pp. 1-5.

Anderson, R. A., C. L. Broadhurst, M. M. Polansky, W. F. Schmidt, A. Khan, V. P. Flanagan, N. W. Schoene and D. J. Graves. 2004. Isolation and characterization of polyphenol Type-A polymers from cinnamon with insulin-like biological activity. J. Agric. Food Chem. 52: 65-70.

Arshad, M. S., S. M. Batool, M. K. Khan, M. Imran, M. H. Ahmad, F. M. Anjum and S. 2019. Bio-evaluation of functional date bars using rats as model organism against hypercholesterolemia. Lipids Health Dis. 18: 148.

Assirey, E. A. R. 2015. Nutritional composition of fruit of 10 date palm (*Phoenix dactylifera* L.) cultivars grown in Saudi Arabia. J. Taibah Univ. Sci. 9: 75-79.

Ayad, A. A., L. L. Williams, D. A. G. El-Rab, R. Ayivi, H. L. Colleran, S. Aljaloud and S. A. Ibrahim. 2020. A review of the chemical composition, nutritional and health benefits of dates for their potential use in energy nutrition bars for athletes. Cogent Food Agric. 6: 1809309.

Bakhtiari, M., Y. Panahi, J. Ameli and B. Darvishi. 2017. Protective effects of flavonoids against Alzheimer's disease-related neural dysfunctions. Biomed. Pharmacother. 93: 218-229.

Baliga, M. S., B. R. V. Baliga, S. M. Kandathil, H. P. Bhat and P. K. Vayalil. 2011. A review of the chemistry and pharmacology of the date fruits (*Phoenix dactylifera* L.). Food Res. Int. 44: 1812-1822.

Batool, S. A., M. U. Arshad, R. S. Ahmed and F. M. Anjum. 2020. Characterization of different date varieties with special reference to their antioxidant potential and bioevaluation trial against hypercholesterolemia. Pak. J. Agric. Sci. 56: 1133-1140.

Besbes, S., C. Blecker, C. Deroanne, N. E. Drira and H. Attia. 2004. Date seeds: Chemical composition and characteristic profiles of the lipid fraction. Food Chem. 84: 577-584.

Chaari, A., B. Abdellatif, F. Nabi and R. H. Khan. 2020. Date palm (*Phoenix dactylifera* L.) fruit's polyphenols as potential inhibitors for human amylin fibril formation and toxicity in Type 2 diabetes. Int. J. Biol. Macromol. 164: 1794-1808.

Chaira, N., A. Ferchichi, A. Mrabet and M. Sghairoun. 2007. Chemical composition of the flesh and the pit of date palm fruit and radical scavenging activity of their extracts. Pak. J. Biol. Sci. 10: 2202-2207.

Cutter, C. N. 2000. Antimicrobial effect of herb extracts against *Escherichia coli* O157: H7, Listeria monocytogenes, and *Salmonella typhimurium* associated with beef. J. Food Prot. 63: 601-607.

Derouich, M., R. Meziani, B. Bourkhis, Y. Filali-Zegzouti and C. Alem. 2020. Nutritional, mineral and organic acid composition of syrups produced from six Moroccan date fruit (*Phoenix dactylifera* L.) varieties. J. Food Composit. Anal. 93: 103591.

Echegaray, N., M. Pateiro, B. Gullón, R. Amarowicz, J. M.

Misihairabgwi and J. M. Lorenzo. 2020. *Phoenix dactylifera* products in human health-A review. Trends Food Sci. Technol. 105: 238-250.

Eid, N., S. Enani, G. Walton, G. Corona, A. Costabile, G. Gibson, I. Rowland and J. P. Spencer. 2014. The impact of date palm fruits and their component polyphenols, on gut microbial ecology, bacterial metabolites and colon cancer cell proliferation. J. Nutr. Sci. 3: e46.

El Fouhil, A. F., A. M. Ahmed, M. Atteya, R. A. Mohamed, A. S. Moustafa and H. H. Darwish. 2013. An extract from date seeds stimulates endogenous insulin secretion in streptozotocin-induced Type I diabetic rats. Funct. Foods Health Dis. 3: 441-446.

El Hilaly, J., J. Ennassir, M. Benlyas, C. Alem, M. Y. Amarouch and Y. Filali-Zegzouti. 2018. Anti-inflammatory properties and phenolic profile of six Moroccan date fruit (*Phoenix dactylifera* L.) varieties. J. King Saud Univ. Sci. 30: 519-526.

El-Far, A. H., B. E. Oyinloye, M. Sepehrimanesh, M. A. G. Allah, I. Abu-Reidah, H. M. Shaheen, I. Razeghian-Jahromi, A. E. Noreldin, S. K. Al Jaouni and S. A. Mousa. 2019. Date palm (*Phoenix dactylifera*): Novel findings and future directions for food and drug discovery. Curr. Drug Discov. Technol. 16: 2-10.

Abd Elgadir, M. 2021. Selected pharmaceutical values of date fruit. Indian J. Novel Drug Deliv. 13: 18-25.

El-Massry, K., A. El-Ghorab, A. Farouk, S. Hamed, H. Elgebaly, N. Mosa, I. Alsohaimi and A. Mahmoud. 2019. Microencapsulation of date seed oil by spray-drying for stabilization of olive oil as a functional food. Asian J. Sci. Res. 12: 516-523.

El-Mergawi, R. A., M. A. Algeffari and A. Al-Humaid. 2019. Sugar types, phenolic contents, and antioxidant activities for 17 Saudi Arabian date cultivars and their relations with glycemic indices. Int. J. Fruit Sci. 19: 315-325.

Farag, M. A., A. Otify and M. H. Baky. 2021. *Phoenix dactylifera* L. Date fruit by-products outgoing and potential novel trends of phytochemical, nutritive and medicinal merits. Food Rev. Int. 37: 1-23.

Fitzpatrick, F. A. 2004. Cyclooxygenase enzymes: Regulation and function. Curr. Pharm. Des. 10: 577-588.

Ghnimi, S., S. Umer, A. Karim and A. Kamal-Eldin. 2017. Date fruit (*Phoenix dactylifera* L.): An underutilized food seeking industrial valorization. NFS J. 6: 1-10.

Habib, H. M. and W. H. Ibrahim. 2011. Nutritional quality of 18 date fruit varieties. Int. J. Food Sci. Nutr. 62: 544-551.

Hafzan, Y., J. Saw and I. Fadzilah. 2017. Physicochemical properties, total phenolic content, and antioxidant capacity of homemade and commercial date (*Phoenix dactylifera* L.) vinegar. Int. Food Res. J. 24: 2557-2562.

Hasan, M. and A. Mohieldein. 2016. *In vivo* evaluation of anti diabetic, hypolipidemic, antioxidative activities of Saudi date seed extract on streptozotocin induced diabetic rats. J. Clin. Diagn. Res.10: FF06-FF12.

Hussain, M. I., M. Farooq and Q. A. Syed. 2020. Nutritional and biological characteristics of the date palm fruit (*Phoenix dactylifera* L.)-A review. Food Biosci. 34: 100509.

Idowu, A. T., O. O. Igiehon, A. E. Adekoya and S. Idowu. 2020. Dates palm fruits: A review of their nutritional components, bioactivities and functional food applications. AIMS Agriculture KSA Food. 5: 734-755.

Jakubowska, M. A., P. E. Ferdek, O. V. Gerasimenko, J. V. Gerasimenko and O. H. Petersen. 2016. Nitric oxide signals are interlinked with calcium signals in normal pancreatic stellate cells upon oxidative stress and inflammation. Open Biol. 6: 160149.

Jarrar, A. H., A. Kamal-Eldin, M. A. Bataineh and A. S. Al Dhaheri. 2019. Glycemic index (GI) and glycemic load (GL) values for dried bisr and tamr dates. Emirates J. Food Agric. 31: 88-94.

Khalid, S., A. Ahmad, T. Masud, M. Asad and M. Sandhu. 2016. Nutritional assessment of Ajwa date flesh and pits in comparison to local varieties. J. Plant Anim. Sci. 26: 1072-1080.

Khan, F., F. Ahmed, P. N. Pushparaj, A. Abuzenadah, T. Kumosani, E. Barbour, M. Alqahtani and K. Gauthaman. 2016. Ajwa date (*Phoenix dactylifera* L.) extract inhibits human breast adenocarcinoma (MCF7) cells *in vitro* by inducing apoptosis and cell cycle arrest. PLoS One. 11: e0158963.

Khan, S., R. Arya, B. Pooja, V. Manju and I. Singh. 2021. A review paper on fruit nutrition and health benefits. Pharma Innov. J. 10: 119-123.

KSA General Authority for Statistics. 2015. Detailed Results Agricultural Census 2015. Agriculture KSA. Retrieved on December 15, 2021 Available from: https://www.stats.gov.sa/en/765.

Lin, W. W. and M. Karin. 2007. A cytokine-mediated link between innate immunity, inflammation, and cancer. J. Clin. Invest. 117: 1175-1183.

Maldonado-Celis, M. E., E. M. Yahia, R. Bedoya, P. Landázuri, N. Loango, J. Aguillón, B. Restrepo. and J. C. G. Ospina. 2019. Chemical composition of mango (*Mangifera indica* L.) fruit: Nutritional and phytochemical compounds. Front. Plant Sci. 10: 1073.

Mallhi, T. H., M. I. Qadir, M. Ali, B. Ahmad and Y. H. Khan. 2014. Ajwa date (*Phoenix dactylifera*): An emerging plant in pharmacological research. Pak. J. Pharm. Sci. 27: 607-616.

Mann, J. I., I. De Leeuw, K. Hermansen, B., Karamanos, B. Karlström, N. Katsilambros, G. Riccardi, A. Rivellese, S. Rizkalla and G. Slama. 2004. Evidence-based nutritional approaches to the treatment and prevention of diabetes mellitus. Nutr. Metab. Cardiovasc. Dis. 14: 373-394.

Maqsood, S., O. Adiamo, M. Ahmad and P. Mudgil. 2020. Bioactive compounds from date fruit and seed as potential nutraceutical and functional food ingredients. Food Chem. 308: 125522.

Metoui, M., A. Essid, A. Bouzoumita and A. Ferchichi. 2019. Chemical composition, antioxidant and antibacterial activity of Tunisian date palm seed. Polish J. Environ. Studies. 28: 1-8.

Mia, M. A. T., M. G. Mosaib, M. I. Khalil, M. A. Islam and S. H. Gan. 2020. Potentials and safety of date palm fruit against diabetes: A critical review. Foods. 9: 1557.

Micha, R., J. L. Peñalvo, F. Cudhea, F. Imamura, C. D. Rehm and D. Mozaffarian. 2017. Association between dietary factors and mortality from heart disease, stroke, and Type 2 diabetes in the United States. JAMA. 317: 912-924.

Mirza, M. B., A. I. Elkady, A. M. Al-Attar, F. Q. Syed, F. A. Mohammed and K. R. Hakeem. 2018. Induction of apoptosis and cell cycle arrest by ethyl acetate fraction of *Phoenix dactylifera* L.(Ajwa dates) in prostate cancer cells. J. Ethnopharmacol. 218: 35-44.

Mohammadi, M., M. Soltani, A. Siahpoosh and M. Shamsaie. 2018. Effects of dietary supplementation of date palm (*Phoenix dactylifera*) seed extract on body composition, lipid peroxidation and tissue quality of common carp (*Cyprinus carpio*) juveniles based on the total volatile nitrogen test. Iran. J. Fisheries Sci. 17: 394-402.

Mrabet, A., G. Rodríguez-Gutiérrez, F. Rubio-Senent, H. Hamza, R. Rodríguez-Arcos, R. Guillén-Bejarano, M. Sindic and A. Jiménez-Araujo. 2017. Enzymatic conversion of date fruit fiber concentrates into a new product enriched in antioxidant soluble fiber. LWT. 75: 727-734.

Negi, P. S., C. Anandharamakrishnan and G. Jayaprakasha. 2003.

Antibacterial activity of *Aristolochia bracteata* root extracts. J. Med. Food. 6: 401-403.

Nehdi, I., S. Omri, M. Khalil and S. Al-Resayes. 2010. Characteristics and chemical composition of date palm (*Phoenix canariensis*) seeds and seed oil. Ind. Crops Prod. 32: 360-365.

Niazi, S., I. M. Khan, I. Pasha, S. Rasheed, S. Ahmad and M. Shoaib. 2017. Date palm: Composition, health claim and food applications. Nat. Prod. Nanotechnol. 2: 9-17.

Perveen, K., and N. A. Bokahri. 2020. Comparative analysis of chemical, mineral and *in-vitro* antibacterial activity of different varieties of date fruits from Saudi Arabia. Saudi J. Biol. Sci. 27: 1886-1891.

Perveen, K., N. A. Bokhari and D. A. Soliman. 2012. Antibacterial activity of *Phoenix dactylifera* L. leaf and pit extracts against selected Gram negative and Gram positive pathogenic bacteria. J. Med. Plants Res. 6: 296-300.

Proteggente, A. R., A. S. Pannala, G. Paganga, L. V. Buren, E. Wagner, S. Wiseman, F. van de Put, C. Dacombe and C. A. Rice-Evans. 2002. The antioxidant activity of regularly consumed fruit and vegetables reflects their phenolic and Vitamin C composition. Free Radic. Res. 36: 217-233.

Radfar, R., M. Farhoodi, I. Ghasemi, A. M. Khaneghah, F. Shahraz and H. Hosseini. 2019. Assessment of phenolic contents and antioxidant and antibacterial activities of extracts from four varieties of Iranian date Palm (*Phoenix dactylifera* L.) seeds. Appl. Food Biotechnol. 6: 173-184.

Rahib, L., M. R. Wehner, L. M. Matrisian and K. T. Nead. 2021. Estimated projection of US cancer incidence and death to 2040. JAMA Netw. Open. 4: e214708.

Rahmani, A. H., S. M. Aly, H. Ali, A. Y. Babiker and S. Srikar. 2014. Therapeutic effects of date fruits (*Phoenix dactylifera*) in the prevention of diseases via modulation of anti-inflammatory, anti-oxidant and anti-tumour activity. Int. J. Clin. Exp. Med. 7: 483-491.

Rambabu, K., G. Bharath, A. Hai, F. Banat, S. W. Hasan, H. Taher and H. F. M. Zaid. 2020. Nutritional quality and physico-chemical characteristics of selected date fruit varieties of the United Arab Emirates. Processes. 8: 256.

Saleem, S. A. 2005. Aspects of Ripning of Dhakki Dates (*Phoenix dacylifera* L.) and Post Harvest Stability Employing Hurdle Technology. PhD, Gomal University, Pakistan.

Sarma, C., G. Mummaleti, V. Sivanandham, S. Kalakandan, A. Rawson and A. Anandharaj. 2022. Anthology of palm sap: The global status, nutritional composition, health benefits & value added products. Trends Food Sci. Technol. 119: 530-549.

Shanmugapriya, M. and K. Patwardhan. 2012. Uses of Date Palm in Ayurveda. Dates: Production, Processing, Food, and Medicinal Values. 1st ed. CRC Press, Boca Raton.

Sheikh, B. Y., S. N. K. Zihad, N. Sifat, S. J. Uddin, J. A. Shilpi, O. A. Hamdi, H. Hossain, R. Rouf and I. A. Jahan. 2016. Comparative study of neuropharmacological, analgesic properties and phenolic profile of Ajwah, Safawy and Sukkari cultivars of date palm (*Phoenix dactylifera*). Orient. Pharm. Exp. Med. 16: 175-183.

Siddeeg, A., X. A. Zeng, A. F. Ammar and Z. Han. 2019. Sugar profile, volatile compounds, composition and antioxidant activity of Sukkari date palm fruit. J. Food Sci. Technol. 56: 754-762.

Siddiqi, S. A., S. Rahman, M. M. Khan, S. Rafiq, A. Inayat, M. S. Khurram, T. Seerangurayar and F. Jamil. 2020. Potential of dates (*Phoenix dactylifera* L.) as natural antioxidant source and functional food for healthy diet. Sci. Total Environ. 748: 141234.

Siddiqui, M. Z. 2011. *Boswellia serrata*, a potential antiinflammatory agent: An overview. Indian J. Pharm. Sci. 73: 255-261.

Siegel, R. L., K. D. Miller, A. G. Sauer, A. S. Fedewa, L. F. Butterly, J. C. Anderson, A. Cercek, R. A. Smith and A. Jemal. 2020. Colorectal cancer statistics, 2020. CA Cancer J. Clin. 70: 145-164.

Subash, S., M. M. Essa, A. Al-Asmi, S. Al-Adawi and R. Vaishnav. 2014. Chronic dietary supplementation of 4% figs on the modification of oxidative stress in Alzheimer's disease transgenic mouse model. Biomed Res. Int. 2014: 546357.

Tafti, A. G. and M. Fooladi. 2006. A study on the physico-chemical properties of Iranian Shamsaei date at different stages of maturity. World J. Dairy Food Sci. 1: 28-32.

Taleb, H., S. E. Maddocks, R. K. Morris and A. D. Kanekanian. 2016. Chemical characterisation and the anti-inflammatory, anti-angiogenic and antibacterial properties of date fruit (*Phoenix dactylifera* L.). J. Ethnopharmacol. 194: 457-468.

Tang, Z. X., L. E. Shi and S. M. Aleid. 2013. Date fruit: chemical composition, nutritional and medicinal values, products. J. Sci. Food Agric. 93: 2351-2361.

Trabzuni, D. M., S. E. B. Ahmed and H. M. Abu-Tarboush. 2014. Chemical composition, minerals and antioxidants of the heart of Date Palm from three Saudi cultivars. Food Nutr. Sci. 5: 1379.

Tsao, R. 2010. Chemistry and biochemistry of dietary polyphenols. Nutrients. 2: 1231-1246.

Uddin, M. S. and Z. Nuri. 2021. Nutritional values and pharmacological importance of date fruit (*Phoenix dactylifera* Linn): A review. J. Curr. Res. Food Sci. 2: 27-30.

Ugulu, I., Y. Dogan, S. Baslar and O. Varol. 2012. Biomonitoring of trace element accumulation in plants growing at Murat Mountain. Int. J. Environ. Sci. Technol. 9: 527-534.

Varijakzhan, D., C. M. Chong, A. Abushelaibi, K. S. Lai and S. H. E. Lim. 2020. Middle Eastern plant extracts: An alternative to modern medicine problems. Molecules. 25: 1126.

Vayalil, P. K. 2002. Antioxidant and antimutagenic properties of aqueous extract of date fruit (*Phoenix dactylifera* L. *Arecaceae*). J. Agric. Food Chem. 50: 610-617.

Wu, X., G. R. Beecher, J. M. Holden, D. B. Haytowitz, S. E. Gebhardt and R. L. Prior. 2004. Lipophilic and hydrophilic antioxidant capacities of common foods in the United States. J. Agric. Food Chem. 52: 4026-4037.

Zhang, C. R., S. A. Aldosari, P. S. Vidyasagar, K. M. Nair and M. G. Nair. 2013. Antioxidant and anti-inflammatory assays confirm bioactive compounds in Ajwa date fruit. J. Agric. Food Chem. 61: 5834-5840.

Zhang, C. R., S. A. Aldosari, P. S. Vidyasagar, P. Shukla and M. G. Nair. 2017. Health-benefits of date fruits produced in Saudi Arabia based on *in vitro* antioxidant, anti-inflammatory and human tumor cell proliferation inhibitory assays. J. Saudi Soc. Agric. Sci. 16: 287-293.