



A comprehensive review on nutritional composition, medicinal value, and processed products of Date Fruit (*Phoenix dactylifera* L.)

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Abstract

Increasing awareness of health and changes in consumer eating patterns has led to an increased demand for fruits and vegetables. Date fruit (*Phoenix Dactylifera L*) is one of the nutritious fruits grown widely across various countries such as Saudi Arabia, North Africa, the Middle East, and Pakistan. Dates are an abundant source of phytochemicals (phenolics, carotenoids, phytosterols, flavanols, flavones, and flavonoid glycosides) and possess various medicinal benefits (Anti-inflammatory Gonadotropic action, Prevention, and Control of Diabetes Mellitus, Anti-tumour activity). The current review focuses on various aspects of date fruit, including developmental stages (kimiri, khala, rutab, and tamer), nutritional composition, medicinal benefits, and industrial applications. Further, the review summarises the use of date fruit components for the development of various novel food products such as date juice, date syrup, date paste has received considerable attention over the last two decades. Furthermore, the application of date fruit as a sugar substitute has been highlighted in bakery and confectionary based products.

Keywords: Morphology, chemical composition, medicinal benefits, date fruit-based products, industrial uses.

1. Introduction

1.1 History

About 6000 years ago, date fruit cultivation started in North Africa and the Middle East (Jabeen *et al.*, 2020; Selim *et al.*, 2012). Date Palm (*Phoenix Dactylifera* L.) is the main cultivating crop in arid regions like Arabian Peninsula, Middle East, and North Africa (H. I. Mohamed *et al.*, 2021; Tengberg, 2012). Previously over the 300 years, these were also grown in South Africa, United States, Pakistan, Mexico, India, South America, and Australia (Ghnimi *et al.*, 2017; Siddiqi *et al.*, 2020; Taleb *et al.*, 2016; Tengberg, 2012). In many countries, dates are cultivated by local people as a staple food (Chao *et al.*, 2007). The record shows that the earliest production was noted in early 3000 BC and is providing food for people for the last 5000 years (Ghnimi *et al.*, 2017). Middle East people have a humongous cultural and spiritual importance for dates (Ghnimi *et al.*, 2017; Siddiqi *et al.*, 2020; Taleb *et al.*, 2016; Tengberg, 2012). Additionally, date fruits are cultivated in ancient Palestinian, Syrian, Libyan, and Egyptian writings (Chao *et al.*, 2007). In the holy Quran, it is written that dates have a religious significance, and it is consumed in the Ramadan month to break the fast besides the part of daily routine (Shafaghat, 2010). A total of 54% of world production of date palm fruit is contributed by five countries, namely: United Arab Emirates (1.08 million tons), Egypt (1.08 million tons), Iraq (1.08 million tons), Saudi Arabia (1.08 million tons) which is known as the mother country for date fruit and Iran with (0.95 million tons) (Aljaloud *et al.*, 2020). More than 2000 varieties of date fruits are grown on this earth (Siddiqi *et al.*, 2020). Due to its long life and yields, the date palm is considered a tree of life, sacred tree, and bread for the desert (Al-Harrasi *et al.*, 2014; Chao *et al.*, 2007; Sassi *et al.*, 2020). Furthermore, the future rise in demand for the date fruit cultivation is expected owing to severe uncertainty in the global food supply chain. Overall, the current review focuses on the date fruit morphology, nutritional value, health benefits and its utilization in the industry for processed products such as date jam.

1.2 Maturity stages of the fruit

There are four stages in the developmental phase of the fruit. The date becomes green in color in its early 4-5 weeks before the developmental stage known as ‘altalaa.’ The various stages of maturity of the date fruit are namely, Kimiri, Khalal, Rutab, and Tamer (Allaith, 2008; Guido *et al.*, 2011; Taain, 2013).

Stage 1. Kimiri: It is further divided into two phases (Allaith, 2008; Chaira *et al.*, 2009):

Phase 1 is characterized by a great increase in size and weight, high acidity, high moisture, and high sugar content. Further, phase 2 is characterized by reduced acidity, increased moisture content than phase 1, and a decrease in size and weight. The average fruit length and width were observed to be 27.5mm and 17.8 mm, respectively. The average weight of the fruit was 5.8 grams. The proximate composition of the fruit were 3.7% ash, 0.5% fat, and 5.6 & protein (Allaith, 2008; Chaira *et al.*, 2009; Thouri *et al.*, 2017).

Stage 2. Khalal: Depending on the cultivar, color changes from green to yellow or red (3-5 weeks) (Allaith, 2008; Guido *et al.*, 2011; Martín-Sánchez *et al.*, 2014; Taain, 2013). The average fruit length and width of the date fruit were 32.5 mm and 21 mm, respectively. 8.7% rise in the fruit weight was observed. The proximate compositions were found to be 2.7% protein, 2.8% ash, and 0.7% ash (Martín-Sánchez *et al.*, 2014).

Stage 3. Rutab: In this stage, date fruit losses moisture becomes soft (2-4 weeks). Decrease in protein, fat, and ash was observed, i.e., 2.6%, 0.3%, and 26%, respectively (Allaith, 2008; Singh *et al.*, 2012).

Stage 4. Tamer: The color changes to dark, and few dates do not have this stage of maturity. The proximate composition are 2.3% protein, 0.2% fat and 1.7% ash (Al-Shahib *et al.*, 2003).

1.3 Cultivation of the fruit

Phoenix is the genus of the date palm, and it belongs to the family palmaceae (Agboola *et al.*, 2013; Al-Shahib *et al.*, 2003; Aljaloud *et al.*, 2020; E. Assirey, 2015; Ghnimi *et al.*, 2017). The cultivation of date fruit is a significant component of dessert farming in Texas, Arizona, and South California (Borchani *et al.*, 2010; Ghnimi *et al.*, 2017; Guido *et al.*, 2011; H. I. Mohamed *et al.*, 2021; R. M. Mohamed *et al.*, 2014). A date palm tree is the major cultivated crop of highly exporting Middle East nations. Unlike others, date fruits semi-dried naturally preserved fruits and complete ripening takes on the tree. Semi-dried, fully ripened dates are nutritionally inferior to fresh dates (Guido *et al.*, 2011; Vayalil, 2012). The average life of a date palm tree is about 40-50 years (Al-Khateeb *et al.*, 2019). Owing to biological features of the date palm, its cultivation differs from perennial crops (Krueger, 2021). The tree needs to be accessed for covering, harvesting, pruning, and pollination (Chao *et al.*, 2007; Krueger, 2021). The pollination of date trees is by wind, and insect pollination is also available (Shafique *et al.*, 2011). To achieve artificial pollination, male trees are grown in the garden for the collection of pollen (Chao *et al.*, 2007). North Africa and the middle east are following this artificial pollination for thousands of years (Shafique *et al.*, 2011). Normally between female and male cultivars, partial incompatibility or incompatibility was existed. Fertilization happens only for one ovule in a flower which produces the date fruit

(Chao *et al.*, 2007; Krueger, 2021). The size and shapes of the seeds are affected by different pollen origins; this is known as the “xenia effect” (Salomon-Torres *et al.*, 2017). This can also affect the outside of the embryo and endosperm, known as the “metaxenia effect” (Salomon-Torres *et al.*, 2017). After pollination, to balance the weight of the fruit, branches are connected to the leaf stalks. To improve the fruit quality, early fruit ripening and bigger fruits fruit thinning method is used. This can be done in three ways: Total bunches removal, decrease in the number of strands per bunch, and decrease in the number of fruits per strand. Bagging is done to save the bunches from high rain, humidity, and sunburn (Chao *et al.*, 2007; Krueger, 2021; Salomon-Torres *et al.*, 2017). Flood irrigation is the oldest method. For the recent plantations, drip irrigation, micro-sprinkler, and sprinkler are used. Manure has been employed traditionally in date production; for industrialized production, inorganic fertilizers are used. Intercropping is possible in date production. Male seedlings of date palm fruits cannot be identified until 4-5 years of their flowering (Chao *et al.*, 2007). A date can be propagated by three methods namely, Tissue culture propagation by organogenesis or embryogenesis of shoot tips, Vegetative propagation of the offshoots, and sexual crosses of the seedlings are not similar to the maternal trees (Agboola *et al.*, 2013; Allaith, 2008; Borchani *et al.*, 2012; Bouhlali *et al.*, 2020; Chaira *et al.*, 2009; R. M. Mohamed *et al.*, 2014; Sassi *et al.*, 2020). Date trees have a 20-40 cm cross-sectional area and are 5-25 m tall in length (Agboola *et al.*, 2013; Al-Khateeb *et al.*, 2019; Al-Shahib *et al.*, 2003; Al-Turki *et al.*, 2010; Bouhlali *et al.*, 2020; Chao *et al.*, 2007; Farahnaky *et al.*, 2011). The stem can be used in making plywood that has strong cellulose fibers. More than 2000 fresh types are almost available all the time of the year. Dry date varieties are available with added sugars and preservatives (Al-Shahib *et al.*, 2003).

2. Nutritional Composition

Date fruit is composed of sugars, and it is very sweet; it constitutes 50-80% of total weight (Agboola *et al.*, 2013; Ali *et al.*, 2009; Aljaloud *et al.*, 2020; E. Assirey, 2015; E. A. R. Assirey, 2015). The calorific value of fresh dates is 157 cal, whereas, for dry dates, it is about 300 cal for 100 g serving (Agboola *et al.*, 2013; Hussain *et al.*, 2020; Sadiq *et al.*, 2013). The seed or pit of date has more oil content than the flesh date. Date fruit has 23 different amino acids in a protein, which are not present in famous fruits such as bananas, apples, and oranges. The six vitamins present in date fruit are vitamin C, nicotinic acid (niacin), vitamin A, vitamin B1 thiamine, and vitamin B2 riboflavin, 0.5-3.9% pectin content lowers the cholesterol content in date fruit (Al-Shahib *et al.*, 2003).

2.1 Carbohydrate

Due to the high carbohydrate amount, date fruit provides a high calorific value. The main reducing sugars include glucose, mannose, maltose, and fructose. The non-reducing sugar (sucrose) constitutes about 70-80%. It also contains few amounts of cellulose and starch (Al-Shahib *et al.*, 2003). The 100 g serving of date fruit has 75 g of carbohydrate. The fructose and glucose portions are almost equal, and its amount gets increased as it attains maturity (Assirey, 2014; E. Assirey, 2015). The carbohydrate content varies depending on different factors like humidity, harvest, post-harvest factors, temperature, type of cultivar and use of fertilizer, etc. (Tang *et al.*, 2013). Concentrations of sugars in different maturity stages are as follows: Kimiri: 3.4 - 7.7%, Khalal: 18.8 – 31.9%, Rutab: 43.9 – 50.1%, and Tamer: 44.3 – 64.1% (Allaith, 2008; Chaira *et al.*, 2009; Guido *et al.*, 2011; Martín-Sánchez *et al.*, 2014; Taain, 2013; Thouri *et al.*, 2017).

2.2 Protein

The protein content of date fruit ranges from 1-7%, quietly high compared to the other fruits. The number of protein decreases as it attains maturity, i.e., from 5.5-6.4% (Kimiri) to 2.0-2.5% (tamer). Studies have reported that 23 types of amino acids are in protein, absent in fruits like bananas, oranges, and apples. The molecular weight ranges from 12,000 to 72,000 Daltons. (Tang *et al.*, 2013). The solubility of proteins varies from soluble albumins to globulins. Proteins can be classified into two types simple proteins and conjugated proteins. Conjugated proteins are further divided into different categories based on the organic or inorganic molecule attached to the amino acids. (Chemical Properties of 11 Date Cultivars and Their Corresponding Fiber Extracts, 2010). Protein structures and protein profiles of Middle Eastern country dates are similar and have a good protein content, whereas dates grown in the US have low protein and simple protein mixtures. (Aljaloud *et al.*, 2020)

2.3 Lipids

Fat concentration in date fruit is very less, and it ranges from 0.1 – 0.9%. Date fruit contains the main fatty like palmitic, myristic, oleic, lauric acids, etc. Date fruit seed oil contains 5 to 10 different types of fatty acids. 7.7 to 9.7% oil is present in the seed portion. The fatty acid content is different for both flesh and dry dates. The fat content decreases from kimiri to tamer stage. The oil contains 10% polyunsaturated fatty acids, 40% monounsaturated fatty acids, and 50% saturated fatty acids (Ahmed *et al.*, 2016; Guido *et al.*, 2011; Manach *et al.*, 2005; Temme *et al.*, 2002).

2.4 Minerals:

Date fruit contains a minimum of 15 different minerals like Magnesium, manganese, phosphorus, iron, calcium, potassium, sodium, and zinc. It has greater amounts of selenium, Magnesium, and potassium—medium amounts of manganese, iron, phosphorus, cobalt, fluorine, zinc, and calcium (Bouhlali *et al.*, 2020; Hussain *et al.*, 2020; H. I. Mohamed *et al.*, 2021). Dates can be used as a better substitute for iron-lacking foods without leading to any harmful effects like anorexia, headache, and nausea. Various factors influence the mineral concentration of dates, such as the type of cultivar, soil fertility, and ripening stages. The concentration of mineral content increases on attaining the maturity stage, i.e., tamer. Dates have extremely low amounts of sodium and high amounts of potassium. The important micro mineral zinc is also present in high amounts, especially mejdool date varieties with 2-11 times higher than US date varieties. Selenium acts as a coenzyme in the mechanism of antioxidant activity. Apart from the health benefits, these minerals are an excellent source for muscle cells, nerve cells, soft tissues, bone, and hemoglobin (Al-Farsi* *et al.*, 2008).

2.5 Vitamins:

Vitamins are major components that occur in many foods. The consumable amounts are less, but they are important for healthy balance and vital functions. Liver stores an excess amount of vitamins. These are essential for carbohydrate, protein, and fat metabolism (Al-Farsi* *et al.*, 2008). Date fruit has a minimum of 6 vitamins. Vitamins present in date fruit are folic acid Vitamin A, Vit C, niacin (nicotinic acid) and vit B1, B2. Vitamin concentration decreases from kimiri stage to tamar stage. Dates are rich in B- complex vitamins, namely thiamine (B1), folate (B9), riboflavin (B2), pantothenic acid (B5), pyridoxine (B6), and niacin (B3). Compared to dry dates, fresh dates have a high amount of vitamins (Hussain *et al.*, 2020; H. I. Mohamed *et al.*, 2021).

2.6 Dietary fiber:

Date fruit contains more insoluble dietary fiber composed of lignin, cellulose, hemicellulose, and insoluble proteins. It also contains non-carbohydrate compounds such saponins, waxes, phytates cutin, and polyphenols (Hussain *et al.*, 2020; Jabeen *et al.*, 2020; H. I. Mohamed *et al.*, 2021; Siddiqi *et al.*, 2020) Due to the loss of moisture, dry dates have more amount of dietary fiber compared to fresh dates. 100 g serving of dates gives a daily intake of 32% of recommended dietary fiber. Dietary fiber reduces the occurrence of bowel cancer and diverticular diseases (Al-Farsi* *et al.*, 2008). Low-quality dates with a high amount of dietary fiber (10%) can be widely used for industrial applications. Crude fiber is also useful in liquid sugar date production (Bhathena *et al.*, 2002; Elleuch *et al.*, 2008)

2.7 Enzymes

The enzymes of date palm include cellulase, invertase, 4- β -D-glucanase, polyphenol oxidase pectin methylesterase, and β -galactosidase, endo-1. The activity of the enzyme changes with the developmental stage of the date fruit. These enzymes play a major role in the maturation of the fruit and tissue softening from kimiri stage to tamer stage; the invertase enzyme activity increases, which hydrolyses the sucrose into glucose and fructose. Propectin is converted into soluble pectin by pectin methylesterase. The activity of β -galactosidase and cellulase is relatively low at kimiri stage, and it gradually increases in tamer stage. For the metabolism of tannins, polyphenol oxidase is needed, Whose activity decreased from kimiri to tamer stage (Al-Hooti *et al.*, 2002).

2.8 Phytochemicals

Dates have a high amount of phytochemicals which are an abundant source of antioxidants. The phytochemicals include phenolics, carotenoids, phytosterols, flavonols, flavones, and flavonoid glycosides. The amount of phytochemicals decreases from kimiri to tamer stage. Due to a high concentration of active phenolic acids used in the coloring and flavoring of various food products (Dembinska-Kiec *et al.*, 2008; Shafaghat, 2010).

2.8.1 Carotenoids

Date fruit contains main carotenoids like neoxanthin, β carotene, lutein, and zeaxanthin. The number of carotenoids in date fruit depends on few factors like ripening stage, type of cultivar, and post-harvest conditions. Studies reported that a decrease in the carotenoid content was observed from kimiri to tamer ripening stage. After solar drying, 4-30% concentration was degraded. (Tang *et al.*, 2013). In the lipid content of date, fruit carotenoids are present. Carotenoids have 600 isoprenoid units which are structurally similar and synthesized by fungi, bacteria, and plants. The concentration of beta carotene in date fruit has a direct relation with the provitamin A activity. For those living in hot climatic regions, the date fruit is a better supplement for vitamin A. Loss of moisture is responsible for decreasing the carotenoid content, and it is not related to the appearance of the date fruit (Ahmed *et al.*, 2016; Taain, 2013).

2.8.2 Phenolic acids

Phenolic acids are the most prominent bioactive compounds of benzoic or cinnamic acid derivatives. The two types of phenolics acids include a free form (Syringic, vanillic and ferulic acid) and bounded form (Gallic acid, caffeic acid, p-coumaric acid, and p-hydroxybenzoic acid).The content of phenolic acids depends on the factors like climate conditions, type of cultivar, etc. Phenolic acid protects the plant from various pests, insects,

and infective pathogens. After drying or dehydration, phenolic acid content decreases gradually, which leads to enzyme activity degradation. These are used as a better substitute for the improvement of color and flavor in many food products (Ahmed *et al.*, 2016).

2.8.3 Flavanoids

Major compounds include anthocyanins, proanthocyanins, and flavonoid glycosides. Flavonoid glycosides like luteolin, quercetin, and apigenin are found in sulfated and methylated forms. Anthocyanins are used as natural colors for various food products because of their antioxidant capacity. This shows the direct correlation between them. Due to the drying process, anthocyanin content gets decreased in date fruit (E. Assirey, 2015). Other parameters like sunlight, storage period, and agronomic conditions are also responsible for decreasing anthocyanin content. Proanthocyanins are a high molecular weight of hepta decamers and decamers. It helps in improving the antioxidant and anti-mutagenic activity (Al-Farsi* *et al.*, 2008).

2.8.4 Phytosterols

These are fat-soluble bio active compounds. It includes spinasterone, β -sitosterol, campesterol, lupeol, stigmasta-5,22-dien-3- β -ol, lupenone, sitosterol, 24-methylenecycloartanol, (E)-24-propylidenecholesterol, cholesta-3,5-diene, stigmastan-3, 5-diene, cholest-4-en-3-one, stigmast-4-en-3-one, and 4-methyl-cholest-4-en-3-one. These are present in edible portion of date fruit (Sablani *et al.*, 2008).

2.8.5 Phytoestrogens

The main components include coumestans, isoflavones, and lignans. Phytoestrogens have a chemical resemblance with estradiol. A biologically active form of phytoestrogens reacts with estrogen receptors and is responsible for estrogenic and anti-estrogenic effects (El-Sharnouby *et al.*, 2014).

3. Health Benefits

Traditional Indian Ayurveda and middle eastern countries are considering date fruit to have many medicinal advantages. Antioxidant activity, Gastrointestinal protective activity, Anti-inflammatory activity, Hepato-protective activity, Gonadotropic activity, Nephroprotective activity, Prevention and Control of Diabetes Mellitus, Anti-tumour activity, Reduction of hypertension and hypercholesteremia levels, and treatment for cerebrovascular and cardio diseases (Alkaabi *et al.*, 2011; Jabeen *et al.*, 2020; Najib *et al.*, 2013; Siddiqi *et al.*, 2020; Taleb *et al.*, 2016).

3.1 Control of diabetes mellitus

Glycemic index is a system of categorizing the foods according to their rise in sugar levels after consumption. The GI of food relying on the physical and chemical properties. A GI value of less than 55 is noted as low, 56-69 is medium, and a value more than 70 is considered as high GI. A proper diet can regulate glycemic levels and improve the metabolic outcomes of the body. In the UAE population aged 30-64 years olds were diagnosed with 29% of diabetes mellitus and 24.2% of pre-diabetes symptoms (Alkaabi *et al.*, 2011). Glycemic load (GL) is the extended concept of the glycemic index, which is defined as the effect of postprandial glucose response with a served proportion of digestible carbohydrates in the diet. The GL values are classified as follows GL with ten or less is considered as low, 11-19 as a medium, and more than 20 considered as high. The high amount of phenols, antioxidants, and minerals helps in the absorption of less glucose into the blood (Alkaabi *et al.*, 2011).

Diabetic patients are deficient in few minerals, which causes the rise of sugar levels in the body. The enzymes present in carbohydrates, namely, α - Amylase and α -glycosidase, were inactivated by the phenolic compounds thereby, reduces the glucose absorption into the blood circulation. Phytoestrogens, namely daidzein, lignans, genistein, and isoflavones, play an important role in reducing the sugar levels in the blood. Phytoestrogens regulate the secretion of pancreatic insulin by maintaining homeostasis. The general symptom of diabetes is hyperglycemia, i.e., hiked oxidative stress, which leads to macro and microvascular diseases. Several studies have proved that diabetic patients have fewer amounts of zeaxanthin, lutein, α - and γ -tocopherol, retinol, lycopene, and β -cryptoxanthin. Hence, it is good for these people to consume dates on a daily basis which have an abundance amount of antioxidants. Apart from antioxidants, phenols and carotenoids present in dates contribute to the prevention and control of sugar levels in circulation. These compounds inhibit ROS production by suppressing the production of ROS enzymes and chelating metals. Minerals such as Cr, Zn, Se, and Mn were helping the control of diabetes mellitus. The date fruit also provides supplements for ascorbic acid in the form of natural antioxidants to the body. Balanced glucose metabolism and regulated insulin secretion improve the health of diabetic patients (Alkaabi *et al.*, 2011; Bhathena *et al.*, 2002; Dembinska-Kiec *et al.*, 2008).

3.2 Antioxidant activity

Date fruit suppresses the oxidation of proteins and neutralizes the free radicle activity. Several studies are conducted for their invitro and invivo antioxidant capacity. Water extracted date fruit has a great suppressing effect on lipid and protein peroxidation in vitro

lab experiments. They scavenge the superoxide and hydroxyl species of oxygen. Antioxidant activity was greatly improved by increasing the polyphenolic content (Vayalil, 2012). The main mineral contributing to the antioxidant activity is Se, which helps in scavenging the free radicles. Selenium works towards the detoxification of (ROS) Reactive Oxygen Species. Along with Se, phytochemicals such as anthocyanins, phenols, and flavonoids help in detoxification. Antioxidant activity depends upon the maturity stage of the date fruit. Generally, un-ripened fruit has a high antioxidant capacity (Sadiq *et al.*, 2013). The three procedures to determine the antioxidant activity are Ferric-Reducing Ability of Plasma (FRAP), Oxygen Radical Absorbance Capacity (ORAC), and DiPhenyl-1-PicrylHydrazyl (DPPH). Specific types of date fruits have more capacity to scavenge the DPPH free radicles. Other medicinal benefits like the protection of nephrons and neurons are responsible for the antioxidant activity (Al-Harrasi *et al.*, 2014; Al-Mamary *et al.*; Al-Turki *et al.*, 2010; Allaith, 2008; Amorós *et al.*, 2009; Ehlenfeldt *et al.*, 2001; Sassi *et al.*, 2020; Silva *et al.*, 2016).

Ferric reducing the ability of plasma (FRAP): At low pH, ferric ion reduces to colored ferrous ion. A study was conducted on 16 date fruit varieties that are cultivated in Bahrain by FRAP assay. The unripe stage has the highest antioxidant capacity (5.71 ± 4.31 mmol/ 100 g fresh weight)(Al-Harrasi *et al.*, 2014; Al-Mamary *et al.*; Al-Turki *et al.*, 2010; Allaith, 2008; Amorós *et al.*, 2009; Sassi *et al.*, 2020; Silva *et al.*, 2016).

Oxygen Radical Absorbance Capacity (ORAC): Free radicles are produced during the thermal degradation of AAPH (2, 2'-azobis (2-amidino-propane) dihydrochloride). The lipophilic and hydrophilic antioxidant capacities were assessed by using this ORAC method. The increased content of retinol, β -carotene, and natural antioxidants in date fruit water extracts and methanol extract improve radicle scavenging activity (Ehlenfeldt *et al.*, 2001).

3.3 Anti-inflammatory activity

Inflammation is one of the main physiological defense systems over different factors like hazardous chemicals, infection, burn, and other responses. LOX and NF-kB are the two transcription factors that have great importance in the inflammation process. These are also associated with other diseases like diabetes and cancer. Inactivation of these transcription factors regulates the unbalanced inflammatory process. Date fruits can be widely used as anti-inflammatory compounds as it inactivates the NF-kB. Former studies have demonstrated that natural flavonoids and phenolic compounds have a main role in the vital action of anti-inflammation (Alkaabi *et al.*, 2011; El-Sharnouby *et al.*, 2014; Rahmani *et al.*, 2014; Tang *et al.*, 2013). Methanolic extraction of date fruit has a vital role in reducing foot inflammation and plasma fibrinogen. Cytokines expressions were regulated by the phenolic compounds,

thereby reducing the swelling action (Al-Qarawi *et al.*, 2005; Rahmani *et al.*, 2014). Anti-inflammatory action was associated with antioxidant activity as it regulates the production of free radicals by inflammatory leukocytes. Consumption of methanolic or water extracted date fruit reduces foot swelling and gained body weight. It also controls the plasma fibrinogen and Erythrocyte sedimentation rate (ESR) (Hussain *et al.*, 2020; D. A. Mohamed *et al.*, 2004; H. I. Mohamed *et al.*, 2021; Rahmani *et al.*, 2014; Taleb *et al.*, 2016).

3.4 Anti-tumor activity

Excess generation of reactive radicals of oxygen species was responsible for different types of cancers. Change in the regular action of genes was the major reason for the formation of tumors in the body. However, very few researches have demonstrated anti-tumor activity. Even though chemotherapy and radiotherapy were used, but they have many side effects. Dates containing the beta D-glucan shows the anti-tumor activity with an optimum dose of 1 mg/kg in a tumor (Rahmani *et al.*, 2014). Date constituents like vitamins, phytoestrogens (daidzein and genistein), phenolic compounds (flavonoids and anthocyanins), phenolic acids (gallic acid and ferulic acids) control the mechanism of gene expression without any adverse effects. Also, minerals such as Se, Zn, Mn, Mg, and Cu helps in reducing tumor activity by improving the immune system response (E. A. R. Assirey, 2015; Rahmani *et al.*, 2014; Siddiqi *et al.*, 2020; Tang *et al.*, 2013)

3.5 Nephroprotective activity

A rise in the area and plasma creatinine concentrations can cause adverse damage to the proximal tubules of the nephrons. (Rahmani *et al.*, 2014) Rapid usage of drugs like antibiotics, analgesics, and cytostatics leads to nephrotoxicity. Many studies have been reported that natural antioxidants (Vit C and Vit E), mineral Se, quercetin, and melatonin fractions of date fruit regulates the activities of glutathione peroxidase (GPx), hepatic lipid peroxidation, catalase (CAT), and superoxide dismutase (SOD) thereby, protecting the nephrons (Hussain *et al.*, 2020).

3.6 Anti-mutagenic activity

The metabolic reactions could suppress the salmonella strains TA-48 and TA-100, which produce pyrene-induced mutagenicity. Various researches have been stated that constituents of date fruit like β -carotene, the mineral selenium, proanthocyanidins, phenolic acids, and anthocyanins responsible for the anti-mutagenic effect. Ames mutagenicity assay was used to demonstrate the anti-mutagenic activity (Tang *et al.*, 2013).

3.7 Treatment for cardio and cerebrovascular diseases (CCVD):

Date fruit can be explored as a remedy for controlling hypertension and hypercholesteremia, which are the main factors for this disease. Date fruit plays a crucial role in the stoppage of events that are responsible for the inflammation of the vascular system.

Hypertension: Renin-angiotensin mechanism is a crucial controlling system responsible for a rise in blood pressure. Regulatory action of Angiotensin-converting enzyme (ACE) in the lungs and lining of blood vessels reduces blood pressure. (Tang et al., 2013). Enzyme renin converts the angiotensin to angiotensin 1. By ACE, angiotensin one is converted to angiotensin 2. The inhibitory action of ACE is strongly linear with the α -amylase and α -glucosidase inhibitory activities. Daily consumption of date fruit can balance the sodium and potassium levels in the body. Thereby reducing the occurrence of renal damage, bone demineralization, and CCVD. Date fruit with high concentrations of Mg and Ca controlling hypertension by natural Ca channel blocker (Al-Harrasi *et al.*, 2014; Rahmani *et al.*, 2014; Taleb *et al.*, 2016).

Hypercholesteremia: LDL and HDL levels in plasma are responsible for an increase in the size of the organ and a total hike in the plasma cholesterol. Due to the presence of high proportions of fiber and less amount fat, dates can have an important role in the hypocholesterolemic effect. There are three effective mechanisms for the hypocholesterolemic effect namely, reduction in the bile acids reabsorption and absorption of fat in the intestinal lumen by dietary fiber, dietary fiber fermentation generates short-chain fatty acids, which inhibits cholesterol synthesis by the hepatic system, and low glycemic effect of blood sugar by reduced insulin secretion.

Arthroogenesis is caused by the oxidation of LDL. Oxidation of LDL acts as a major factor for cardiovascular diseases. β -sitosterol regulates the synthesis of fat by suppressing the HMG Co-A reductase gene expression. Date fruit containing polyphenols is a major source of reducing LDL levels. This is responsible for the reduction of atherogenicity, leading to a low risk of CCVD (Al-Harrasi *et al.*, 2014; Farahnaky *et al.*, 2011; Hussain *et al.*, 2020; Oladzad *et al.*, 2021; Sassi *et al.*, 2020)

3.8 Gonado tropic activity

The date palm has been consumed as the main raw ingredient in various tonic confections and aphrodisiacs. Date fruit increases the concentrations of various hormones in rats, namely luteinizing hormone, follicle-stimulating hormone, and testosterone. El-Moggy et al. stated that a rise in sperm count had been observed in guinea pigs. Phytochemicals like

genistein and daidzin protect the functions of testicles over stress by possessing gonadotropic activity (Tang *et al.*, 2013).

3.9 Hepatoprotective activity

Improper functioning of the liver is one of the serious health issues. Date fruit could stop the rise in the concentrations of hepatic enzymes (gamma-glutamyl transferase transaminases, lactate dehydrogenase, and alkaline phosphatase). There are no preventive drugs available for this. The histopathological studies revealed that date fruit has hepatoprotective activity. Many studies reported it is due to the presence of constituents like anthocyanin, proanthocyanidins caffeic acid, quercetin, ferulic acid β -carotene, luteolin, and selenium (Tang *et al.*, 2013).

3.10 Anti-ulcer activity

A beneficial effect for ethanol-induced gastric ulceration in a rat model. A decreased level of ethanol-induced histamine, mucin in gastric mucosa, and plasma gastrin were observed, which removes the gastric ulceration in the stomach line. This is due to the presence of ethanolic and aqueous extracts of date fruit (Al-Qarawi *et al.*, 2005).

1. Medicinal food against fungal and bacterial infections

Along with the other herbs, spices date fruit can be used to cure cold, pulmonary infections, and cough. Date extracts of Brahi varieties inhibit the growth of numerous bacteria such as *salmonella typhi*, *staphylococcus aureus*, *bacillus subtilis*, and *Pseudomonas aeruginosa*. Inhibition of spore germination of subtilis species done by anti-bacterial activity. Incubation of date fruit extracts in both in vitro and in vivo shows the inhibitory action on streptococcus pyrogens (Rahmani *et al.*, 2014; Taleb *et al.*, 2016; Thouri *et al.*, 2017). Date fruit neutralizes the hemolytic action of bacterial species. In anti-fungal activity, date fruit extract destroys the cell membrane integrity, induces the formation of cytoplasmic portions, and removes the plasmalemma from the cell wall. The infection of human buccal epithelial cells (BEC) was reduced after oral consumption of 10% date fruit extract (Al-Harrasi *et al.*, 2014; H. I. Mohamed *et al.*, 2021; Rahmani *et al.*, 2014; Taleb *et al.*, 2016; Thouri *et al.*, 2017)

2. DATE PROCESSED PRODUCTS

Date fruit is processed into different types of food products. To meet the expected qualities of customers, different date packaging techniques are used. This can be consumed without any washing or fumigation.

5.1 Date juice

The simple procedure for making date juice is heating the mixture of seeded and fruit without seeds in water until it boils, then filtration followed by concentration. Date juice is sensitive in open conditions and has the tendency to lose color, vitamins, and flavor during processing. To avoid these problems, some mild techniques are used (Manach *et al.*, 2005). The extraction of juice is carried out in vacuum conditions at a lower temperature. Date juice has adequate anti-mutagenic and antioxidant activity. In Many carbonated and non-carbonated beverages, this can be used as a sugar substitute.

5.2 Dates syrup products

The quality of date syrup is equivalent to date juice, yet it is increasingly concentrated. Date syrup is one of the most well-known date's natural product fruit subsidiaries. For the preparation of syrup khalal stage of date fruit having high soluble sugars at the maturity, development can be used as excellent raw ingredients as the technique for date syrup production includes pitted, extracted with hot water, autoclaved, filtered, and concentrated. Recently, a study reported the recovery of soluble solids acquired by pectinase. Also, cellulase was almost multiple times larger than those were acquired with the conventional hot water and autoclaving extraction strategy (Borchani *et al.*, 2010). The recovery of these soluble solids by these enzymes can be used as a better sucrose replacement in bakery products. Date syrup can be used in bread, beverages, biscuit, ice cream and confectionary, cake as a flavoring, and agent sweetening. Liquid date sugar of TSS content 75% is produced by using refined date syrup and contains a mixture of different sugars (i.e., sucrose, fructose, and glucose). Liquid sugar is utilized mostly in preserved fruits, soft drinks, jellies, confectionery products, cakes, and ice cream (Al-Mamary *et al.*).

5.3 Date paste-based products

Date food producer is keen on delivering date paste since it can lessen transportation and capacity cost as well as can replace low quality dates into value-added product raw materials (Hasnaoui *et al.*, 2011). Date paste can be prepared by grinding the soaked date fruit in boiling water or steaming it under certain reduced pressure. 0.2 % Ascorbic or citric acid is added to improve color and shelf life date paste. Date paste can be used as a better replacement for flour in confectionery and baked products. In bread properties delayed gelatinization, Shelf life extension, improved dough rheological properties, prevents staling, delays the gas retention, gas generation, and improved crumb and crust features with the usage of 4–8 % date paste. Date paste is a cooked meat product, showing the great impact of date paste on the improved quality of meat products. The results indicated that the usage of

date paste into the meat product could reduce its fat portion and improve the nutritive value of the product (Chao *et al.*, 2007). Additionally, date paste can be utilized in preparations of date candy and date power. In order to further improvement of the nutritive estimation of date paste, it very well may be blend in with chocolate, pineapple, skim milk powder, and fruit juices such as strawberry, banana, apple, grape, or orange and convert to a high-protein compound, tamar heap.

5.4 Products from By-products of date processing:

Date processing is accompanied by generous losses of date palm fruits. Lost dates are disposed of because of ill-advised appearance that can't be packaged for marketing. For fermentation, these by-products are used as substrates because of their nutritive value for microbe's metabolism and growth, such as proteins, minerals, sugars, and fiber. Several studies on the ability of by-products used as the substrate for fermentation have been reported (Sablani *et al.*, 2008). Citric acid is produced by using *Aspergillus niger* ATCC 16404 and *Saccharomyces cerevisiae* ATCC 1102 strains. Depending on the capacity date, waste can be used as a substrate for this. The studies reported that under mean fermentation conditions, 0.1264 kg L⁻¹ citric acid could be used. Usage of date juice as a carbon source lactic acid is produced by *Lactobacillus* sp. KCP01. Studies reported that 0.0151 kg L⁻¹ lactic acid could be gotten under the optimization of temperature and pH utilizing date juice as a carbon source.

By using *Gluconacetobacter xylinus* low-quality date syrup for the generation of Bacterial Cellulose. Studies reported that 0.0435 kg L⁻¹ bacterial cellulose could be obtained. Xanthan gum is produced by *Xanthomonas campestris* with date syrup as a substrate. The results showed that expansion of gum concentration could be maximum up to 8.9×10^{-3} kg L⁻¹. An extra carbon source obtained from date syrup can result in a high bleomycin yield (0.138×10^{-3} kg L⁻¹). Incorporation of probiotic microbes such as *Lactobacillus acidophilus* La-5, *Bifidobacterium lactis* Bb-12, and *B. longum* Bb-46 into date pastes. Survival of all probiotic bacteria was possible in date products. In the third week of storage, the moving/live count of *L. acidophilus* stayed over $6 \times 10^{-3} \log_{10}$ CFU kg⁻¹ in date products. *Saccharomyces cerevisiae*, known as bakery yeast strain, utilizes substrates from unadulterated molasses and date syrup. The results demonstrated that the concentration of pure molasses substrates is higher than the total amount of yield from unadulterated date syrup substrate. This is due to the presence of toxic organic acids in date syrup of higher concentrations.

5.5 Other date fruit based products

Date pickles, including chutney, brine and salt-stock pickles, and pickles-in-oil are another major product, can be prepared using kimri and the khalal stages of the date fruit. kimri stage of date fruit mixed with different types of condiments, mustard oil, and spices to prepare Pickles-in-oil product. Chutney is prepared using vegetables, vinegar, date fruit, and hot spices.

Date bars are prepared using date pulp, oak flakes, almonds, and sesame seeds and it is familiarly consumed among small children (Vijayanand *et al.*, 2012a). Such enriched nutrient date bars can provide a required amount of fat, minerals, fiber, and protein. For the preparation of date, butter tamer stage dates fruits are used since it contains high sugar. The preparation of date butter is similar to jam making, only the pH varies. Date pulp is used in the preparation of date jam, and clear date fruit extract is used in the preparation of date jelly (Vijayanand *et al.*, 2012b). A good date jam has a pH of 3.0 to 3.2, sugar concentration is 65 %, and pectin is 1 %. Few date-fruit cultivars, namely Ruzeiz, Sukkary, and Khalas are very affordable for the preparation of jam. Different types of jellies made from date fruits were with greater chewiness, cohesiveness, adhesiveness, and taste properties.

3. INDUSTRIAL USES:

Date fruit can be used as a sugar substitute in the processing of many food products. Conventional purification technique is used to produce sugar from date syrup (Ahmed *et al.*, 2016). It is sent for ethanol production by fermentation. Date fiber concentrates are used as sweeteners in sweetening carbonated drinks. Brightening the color of the dried dates by removing the sloughing of dates and eliminates the sugar spots on the surface (Kaushik *et al.*, 2016). For the nutritional and therapeutic value, date fruit can be processed into tablets or liquid consumables. It changes the palatability of nutraceuticals with an odd taste. Date palm is roasted and used in the espresso machine for coffee-like beverages production. Production of date fruit wine which is rich in phenolics, vitamins, and many minerals. Due to its greater nutritional value used in the preparation of nutritional bars for athletes. Date fruit components are used in the preparation of novel food products (Ghnimi *et al.*, 2017).

4. CONCLUSION:

Date fruit has a major role in date cultivating areas, especially in Middle Eastern countries. The food we consume daily may not provide the required quantity of minerals that we obtain from date fruit consumption. Date fruit is a great source of dietary fiber, vitamins, phytochemicals, and minerals such as selenium. The flavonoid compounds of date fruit include anthocyanins, proanthocyanins, phytoestrogens, include coumestans, isoflavones, and

lignans, and phytosterols. The healing properties of date fruit are anti-inflammatory activity, antioxidant activity, gonadotropic activity, and control of diabetes mellitus. In value addition of food materials date, by-products can be used as raw ingredients. The processed products of date fruit include date juice, date syrup, and date paste. Date fruit is used as a sugar substitute for various food products. Date fruit can be processed for many industrial applications.

CONFLICTS OF INTEREST : The authors declare no conflict of interest.

S.N	Date variety	Moisture	Protein	Fat	Sugars	Ash	Dietary fiber	Reference
1	Alligh	2.61	1.22	0.56	84.5	2.18	11.45	(Hussain et al. 2020; Oladzad et al. 2021; Taleb et al. 2016)
2	Deglet noor	3.26	1.71	0.4	88	1.78	8.09	
3	Bajo	2.2	1.28	0.11	79.9	1.73	16.95	
4	Bufeggous	2.8	1.51	0.14	86.7	1.58	10.05	
5	Goundi	3.62	2.85	0.35	84.7	1.85	10.16	
6	Ikhavat	3.33	0.66	0.07	78.8	2.59	17.82	
7	Kenta	2.12	0.9	0.06	85.1	1.75	12.18	
8	Kentichi	2.23	0.46	0.11	77.4	1.74	20.25	
9	Lagou	3.1	1.83	0.25	77.3	2.08	18.53	
10	Touzerzaillet	1.68	1.49	0.57	78.5	2.11	17.25	
11	Tranja	2.15	2.42	0.14	83.9	2.23	11.26	(Chaira et al. 2007)
12	Ajwa	22.8	2.9	0.47	74.3	3.43	8.75	
13	Shalaby	15.2	4.73	0.33	75.9	3.39	7.76	
14	Khodari	9.5	3.42	0.18	79.4	3.42	8.13	
15	Anabarah	19.5	3.49	0.51	72.4	2.33	6.12	
16	Sukkari	11.2	2.76	0.52	78.5	2.37	7.66	
17	Suqaey	14.5	2.73	0.41	79.7	2.29	2.13	
18	Safawy	21.6	2.48	0.12	75.3	1.68	1.16	
19	Burni	24.4	2.5	0.67	71.4	2.02	5.82	
20	Labanah	10.5	3.87	0.72	71.2	3.94	12.1	
21	Mabroom	21.3	1.72	0.27	76.4	2.79	9.13	
22	Traunja	14.1	2.2	0.6	55.3	2.13	6.9	(Alkaabi et al. 2011)
23	Lagou	13.2	2	0.43	53.5	2.18	6.05	
24	Gounda	13.7	2.1	0.41	51.8	2.15	6.5	
25	Fara'd	13.2	1.16	0.12	68.9	10.2	2.64	
26	Boma'an	14.81	1.39	0.06	68.8	13.2	2.58	
27	Dabbas	12.89	1.6	0.16	65.6	18.6	2.36	
28	Khalas	16.3	1.19	0.12	68.8	12.4	2.5	
29	Godala	8.78	4	2	80.4	2.2	2.53	
30	Barakawi	9.38	4.03	1.87	79.5	2.5	2.67	(El-Sharnouby et al. 2014)
31	Jaw	10.68	3.69	1.79	78.7	2.38	2.74	
32	Mishig	8.81	3.92	2.06	80.2	2.19	2.78	
33	Bittamoda	10.03	3.72	1.81	80.1	1.96	2.37	
34	Madiri	9.9	3.94	1.71	79	2.27	3.14	

Table.2. Nutritional composition of date fruits at different ripening stages

S.No	Date variety	Ripening stage	Total sugars	Protein	Fat	Ash	Moisture	Reference	
1	Naghal	Kimiri	5.1	1.1	0.1	0.8	80.1	(Borchani et al. 2010; Borchani et al. 2012)	
		Khalal	30.6	1.6	0.1	1	54.5		
		Rutab	44.2	2	0.2	1.2	44.1		
		Tamer	44.3	2.2	0.2	1.9	9.2		
2	Buchibal	Kimiri	5.1	1	0.1	0.7	83.7		
		Khalal	18.8	0.9	0.1	0.5	76.5		
		Rutab	49	2.1	0.1	1.1	35.9		
		Tamer	55.1	2.2	0.2	1.5	18		
3	Khunaizy	Kimiri	6.4	1.1	1.1	0.7	84.2		(Al-Harrasi et al. 2014)
		Khalal	23.4	1.1	1.1	0.8	66.5		
		Rutab	46.2	1.9	1.9	1.2	37.9		
		Tamer	53.9	3	3	1.4	25.1		
4	Khulas	Kimiri	7	0.8	0.8	0.7	83.7		
		Khalal	31.9	1.1	1.1	0.9	58.9		
		Rutab	46.2	1.1	1.1	1	41.3		
		Tamer	57	2.1	2.1	1.4	22.3		
5	Gush rabei	Kimiri	5.3	0.7	0.7	0.6	85.1		
		Khalal	24.9	1	1	1	64.1		
		Rutab	48.1	1.4	1.4	1.1	44.7		
		Tamer	49.9	2	2	1.6	25.5		
6	Hilali Ahmr	Kimiri	3.4	0.9	0.9	0.7	84.6		
		Khalal	23	0.9	0.9	0.6	74		
		Rutab	43.6	1.5	1.5	1	45.8		
		Tamer	64.1	2.2	2.2	1.6	31.1		
7	Barhi	Kimiri	7.7	1.1	1.1	0.8	83.2	(Chaira et al. 2007)	
		Khalal	31.1	0.4	0.4	0.9	62.6		
		Rutab	40.8	1.8	1.8	1.1	39.7		
		Tamer	57.2	2.3	2.3	1.5	29.5		
8	Lulu	Kimiri	7.6	1.3	1.3	0.8	81.7		
		Khalal	29.7	1.1	1.1	0.7	62.2		
		Rutab	43.9	1.6	1.6	1	45.2		
		Tamer	57.7	2.4	2.4	1.3	21.3		
9	Fard	Kimiri	5.6	0.9	0.9	0.8	82.7		
		Khalal	27.1	1	1	1	72.1		
		Rutab	50.1	1.5	1.5	1.3	37.6		
		Tamer	59.5	2.1	2.1	1.8	27.7		
10	Naghal hilali	Kimiri	7	0.8	0.8	0.6	85.5	(Aljaloud et al. 2020)	
		Khalal	31.8	1.3	1.3	1	57		

		Rutab	44.8	1.2	1.2	0.8	48.9
		Tamer	52.7	1.9	1.9	1.3	32.1
11	Khasab	Kimiri	7.6	0.8	0.8	0.6	84.6
		Khalal	22.9	1	1	0.8	72.6
		Rutab	41.7	1.1	1.1	1	50.4
		Tamer	49.8	1.6	1.3	1.4	36.2
12	Hilali pakistan	Kimiri	6.6	1	1	0.6	84.2
		Khalal	23.8	0.9	0.9	0.6	70.5
		Rutab	44.1	1.4	1.4	1.1	44.2
		Tamer	51.4	1.7	1.6	1.7	37.3

Table.3. The mineral content of different date varieties

S.No	Date variety	Ca	K	Mg	P	Na	Reference
1	Ajwa	187	4763	150	27	7.5	(Assirey 2014; E. A. R. Assirey 2015; Bouhlali et al. 2020)
2	Kodari	133	289.6	60	16	4.9	
3	Safawy	123	512	56	12	8.6	
4	Burni	168	422.5	100	18	8.9	
5	Gondala	238	862	120	208.7	131.8	(Sahari et al. 2007)
6	Barakawi	276	1088	66	232.1	135.3	
7	Jaw	223	974	111	212.2	139.1	
8	Battimoda	277	722	100	166.6	55.1	
9	Madiri	222	691	66	170	56.7	
10	Mishig	293	733	109	150.1	60.7	(Amorós et al. 2009)
11	Fara'd	1170	511.8	1205	445.9	192.1	
12	Lulu	517.7	476.2	411.1	338.3	93.4	
13	Boma'an	288.6	421.8	561	543.8	47.7	
14	Dabbas	846.5	688.4	604.5	411.8	91.1	
15	Khalas	936.33	827.1	746.1	245.5	121.9	(Rahmani et al. 2014)
16	Alligh	11.1	430.6	30.32	118.21	5.27	
17	Deglet noor	25.05	774.7	50.26	133.4	5.79	
18	Bajo	18.65	533.4	89.17	138.2	8.84	
19	Boufeggous	22.31	447.4	56.05	153.1	8.87	
20	Goundi	20.82	641.2	62.3	117.4	11.77	
21	Ikhout	20.66	575.1	61.15	155.7	8.71	
22	Kenta	26.71	404.9	47.57	157.8	7.04	
23	Kentichi	36.52	476.8	57.43	139.1	8.12	
24	Lagou	14.82	537.6	58.26	126.7	25.14	
25	Touzerzaillet	14.98	544.3	48.27	134.1	13.87	
26	Tranja	19.78	670.9	57.65	156.4	14.66	

Table.4. Nutritional comparison of fresh and dry dates

S.No	Type of date	Date variety	Moisture	Protein	Fat	Carbohydrate	Ash	Dietary fiber	Reference
1.	Fresh dates	Naghal	44.1	2.0	0.2	52.6	1.2	7.1	(Agboola <i>et al.</i> , 2013)
2.		Khunaizy	37.9	1.9	0.1	58.8	1.2	8.6	
3.		Khalas	41.3	1.1	0.1	56.8	1.0	6.85	
4.		Barhi	39.7	1.8	0.2	56.9	1.1	7.5	
5.		Lulu	44.2	1.6	0.2	52.2	1.1	7.62	
6.		Fard	37.6	1.5	0.2	59.4	1.3	8.23	
7.		Khasab	50.4	1.1	0.1	47.8	1.0	6.67	
8.		Bushibal	43.2	1.4	0.1	44.2	1.1	7.12	
9.		Gash gaafar	40.0	1.5	0.1	57.0	1.4	7.33	
10.		Gash Habash	44.2	1.3	0.1	53.1	1.3	8.16	
1.	Dry dates	Naghal	9.2	1.5	0.2	86.2	1.9	8.0	(Agboola <i>et al.</i> , 2013)
2.		Khunaizy	25.1	2.7	0.1	70.5	1.4	8.4	
3.		Khalas	12.6	3.0	0.5	83.4	1.8	6.3	
4.		Barhi	29.5	1.7	0.1	66.1	1.5	8.0	
5.		Lulu	21.3	2.3	0.2	75.1	1.3	6.7	
6.		Fard	18.5	2.4	1.4	77.1	1.5	9.7	
7.		Khasab	16.5	1.5	1.0	79.3	1.6	10.3	
8.		Bushibal	16.3	1.6	0.1	79.9	1.8	8.5	
9.		Gash gaafar	7.2	1.9	0.1	88.6	1.9	8.2	
10.		Gash Habash	12.8	2.2	0.1	83.8	1.6	7.8	

Table.5. Health benefits of date fruit

S.N	Health benefit	Observation	Reference
1.	Anti-inflammatory	<ul style="list-style-type: none"> Inhibits the peroxidation of liver fat. Suppresses the erythrocyte sedimentation rate. 	(D. A. Mohamed <i>et al.</i> , 2004, 2005)

	activity	<ul style="list-style-type: none"> • Destructing the activities of glutathione peroxidase (GPx), Superoxide dismutase (SOD), and catalase (CAT) 	
2.	Antioxidant activity	<ul style="list-style-type: none"> • Counterbalance the hydroxyl radicles and superoxide by inhibiting the protein & lipid oxidation 	(Dembinska-Kiec <i>et al.</i> , 2008)
3.	Gonadotropic activity	<ul style="list-style-type: none"> • Improves the sperm count by spermatogenesis and rises the concentration of the follicle-stimulating hormone testosterone 	(Saryono <i>et al.</i> , 2016)
4.	Control of diabetes milletus	<ul style="list-style-type: none"> • Controls the secretion of insulin thereby, reducing the absorption of glucose into the blood. 	
5.	Treatment for cardio and cerebrovascular diseases	<ul style="list-style-type: none"> • Consumption of date fruit reduces hypertension and hypercholesteremia, which are responsible for CCVD 	(Sassi <i>et al.</i> , 2020)
6.	Anti-cancer activity	<ul style="list-style-type: none"> • Phytochemical compounds of date fruit act against carcinogenic agents 	(Rahmani <i>et al.</i> , 2014)
7.	Anti-ulcer activity	<ul style="list-style-type: none"> • By decreasing the gastrin levels in plasma removes the ulcers in the gastric mucosal line. • Improves the gastrointestinal transit time 	(Bhathena <i>et al.</i> , 2002)
8.	Nephroprotective activity	<ul style="list-style-type: none"> • Generates the expression of IFN – gamma mRNA in cells also improves the immune response 	(Al-Qarawi <i>et al.</i> , 2005)
9.	Neuro-protective activity	<ul style="list-style-type: none"> • The decreased death rate of CA1 hippocampal neurons caused by focal cerebral ischemia 	
10.	Anti-mutagenic activity	<ul style="list-style-type: none"> • Suppresses the benzo (a) pyrene-induced mutagenicity 	(Rahden-Staroń <i>et al.</i> , 2010)

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