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# A review on the nutritional content, functional properties and medicinal potential of dates

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**Abstract**
This review article emphasizes on the nutritional and functional constituents of dates. Dates are found to be rich in carbohydrates (44-88%), mainly glucose and fructose, but low in proteins (2.3-5.6%) and fats (0.2-0.5%). These are also a good source of vitamin B complex, dietary fiber, minerals, phenolics, carotenoids and antioxidants. Due to these important functional compounds, dates exhibit various health benefits by preventing various diseases. Keeping in view the detailed information on nutritional and health promoting components, dates may be considered as an almost ideal food, providing a wide range of essential nutrients and potential health benefits.
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## Introduction

Date palm (*Phoenix dactylifera* L., Arecaceae) is among the oldest plants cultivated on Earth and widely planted in hot and dry climate of Asia, Middle East, Africa and Arabian Peninsula. It is an important food resource of the people of these regions and plays an important role in their day-to-day lives [1, 2]. Date palm fruit is divided into three main parts: date skin, date flesh and pit [2].

Dates are classified either on the basis of their invertase content or sugar composition. Invertase led to the classification of dates into: a) dates which are rich in invertase and contain significant amounts of reducing sugars (about 77%) are referred as soft dates, b) dates with small amount of invertase and contain 39% reducing sugars and 38% sucrose are called semi dry/half soft dates, c) dates without invertase are classified as dry dates. These are rich in sucrose (59%) with small amount of reducing sugars (17%) [3].

Dates are classified into four classes on the basis of sugar contents. The first class of dates is rich in sucrose (40-65%). These contain 20-40% glucose and fructose and 10-25% water contents. The dates present in the second class are rich in glucose and fructose (40-75%) and contain relatively less amount of sucrose (10-35%). The dates in third class are comprised of 10-35% water, 65-90% glucose and fructose and 0-10% sucrose. Fourth class dates have high water content (35-65%). These contain 35-37% glucose and fructose and 0% sucrose.

## Stages of dates ripening

Date fruit pass through the several stages during its development, named as Kimri, Khalal, Rutab, and Tamar [4]. Many studies had characterized the physical and chemical changes occurred in dates as they passed through these stages [4, 5].

### Kimri stage

At kimri stage, the moisture content of fruit is quite high (85%). Date fruit increases in size, weight and sugar content during this stage. The fruit color starts to turn yellow or red at the end of this stage that depends upon date variety.

### Khalal stage

At this stage, dates are red, pink or yellow in color with hard texture. Moisture content of fruit decreases gradually and sucrose starts to be converted to reducing sugars (glucose and fructose). Total soluble solids (TSS) of fruit are 30 – 45 °Brix and weight gain of fruit is slow at this stage and dates starts to lose astringency. In some varieties, sucrose conversion is very fast and fruit is palatable at khalal stage [4].

### Rutab stage

Fruit tip starts to turn brown as it enters to rutab stage. Dates lose their weight due to loss of moisture. The moisture content of fruit at this stage is 35%. Tissue softening and skin browning also occurs at this stage. There is a further conversion of sucrose into glucose and fructose. Dates are free of astringency with TSS of 55 - 60 °Brix and sold as fresh dates.

### Tamar stage

Dates are fully dried at tamar stage with 20% moisture content and are fully ripped with TSS of 60 - 84° Brix [6].

## Date varieties of the world

Nearly 5000 cultivars of date palm (*Phoenix dactylifera* L.) are known in the world, but only some are evaluated due to their fruit quality and performance [7]. Aseel, begum Jangi, Dhakki, Karabalian, Fasli, Muzawati and Halawi are the popular verities of Pakistan. In Iran, the important date varieties are Khenizi, Sayer, Lasht, Kabkab, Shahabi, Majoul, Khazui, Zahedi [8] and Bamy [9]. Deglet nour (semi dry) and Degla beida (dry dates) in Algeria [3], Alligh, Goundi, ikhouat, Lagou, Touzerzaillet and Tranja in Tunisia [10], Suqaey, Sofry, ajwa and Safawy in Saudi Arabia [9], Lobanah Masery [9], saidi in Egypt [11] and Shorcy and Tamriraq in Iraq are the important cultivated date varieties [9].

## Proximate composition of dates

### Moisture content

On the average, moisture content of fresh and dried dates is 42.4g/100 and 15.2g/100g respectively [1, 4, 12]. This reduction in moisture content is mainly due to sun drying that is a common method to preserve dates. Humidity and day time temperature are the factors that affect the sun drying to produce a uniform and high quality product [13]. Actually, moisture content depends on the date fruit ripening stages and it decreases as it ripened for further stage from Kimri to Tamar.

### Carbohydrates

The average content of carbohydrates in fresh and dried dates are 54.9 and 80.6g/100 g respectively. Carbohydrates in dates are mainly sugar and fiber and are a good source of energy. The average energy provided by dried and fresh dates is 314 kcal and 213kcal/100g respectively [1, 12]. Thus 100g of dates can provide about 12-15% energy requirement of an adult.

### Protein, fat and ash

Dates contain small amount of fat and protein. The average protein content of dried dates (2.14g/100g) is more than fresh dates (1.50g/100g) that is due to loss of moisture. Similarly, fat content of dried dates (0.38g/100g) is higher than fresh ones (0.14g/100g). Several factors may affect these values like drying conditions, cultivation and determination methods. The average ash content of dates is about 1.67g/100g [1, 4, 12].

## Nutritional value and functional properties of dates

### Sugars

The main sugars detected in fresh and dried dates are glucose, fructose and sucrose. The average quantity of total sugar in fresh dates is 43.4g/100g of which sucrose, fructose and glucose are about 4.03g, 19.4g, and 22.8g/100g respectively. Sugar level increases as dates move from rutab to tamar stage because of dryness. Total sugar contents of dried dates are 64.1g/100g. Dried dates contain 30.4, 29.4, and 11.6g/100g for glucose, fructose and sucrose respectively [1, 14, 15]. Glucose and fructose were found in almost equal amount in dates and were the main sugars in most date varieties. The difference in sugar level between dried and fresh dates may be due to relation of maturity level and moisture reduction [16].

Reducing sugars are the most important constituent of dates as these are condense source of energy. As compared to sucrose, reducing sugars leads to rapid elevation of blood sugar level due to its readily absorption after digestion [17]. Moreover, fructose causes the feeling of satiety as it is twice as sweet as glucose and as compared to fat rich foods; it may reduce the total calorie intake [18].

### Minerals

Dates are an important and rich source of essential minerals like potassium, magnesium, copper and selenium. Intake of 100g of dates supply about 15% recommended daily allowance of these minerals. Iron, calcium, phosphorus and manganese are present in dates in moderate concentrations and intake of 100 g of dates can supply about 7% recommended daily allowance of these minerals. Low sodium and high potassium level of dates are beneficial for the people suffering from hypertension [19]. On the average, date fruit contains K (713 mg/100 g), Mg (64.2 mg/100 g), Cu (0.24 mg/100 g) and Se (0.31 mg/100 g) [4, 14, 20].

Glutathione peroxidase is an antioxidant enzyme that requires selenium for its working due to its coenzyme action so indirectly it has a key role in the growth and development modulation, maintenance of body defense system against various infections and to protect our body tissues from oxidative stress. Generally, minerals are important constituents of our various tissues and cells like teeth, bone, hemoglobin, soft tissues, muscle and nerve cells [21, 22].

### Vitamins

**V**itamin $B_2$, $B_3$, $B_6$ and $B_9$ are present in moderate concentration in dry dates. Intake of 100g

of dates can supply about 9% of recommended daily allowance of these vitamins. Dates are poor in vitamin A, C and $B_1$ and 100 g of dates can supply about 7% recommended daily allowance of these vitamins. On the average, date fruit contains vitamin A (23.85 $\mu$g), $B_1$ (78.61 $\mu$g), $B_2$ (116.5 $\mu$g), $B_3$ (1442 $\mu$g), $B_6$ (207 $\mu$g), $B_9$ (53.75 $\mu$g) and vitamin C (3900 $\mu$g) [4, 12].

Vitamins are an essential nutrient to maintain our health. Although these are required in very small amount, but they perform very vital and specific functions in our body. Dates are the main source of water soluble vitamins rather than fat soluble vitamins (B-complex and C). These vitamins act as co-enzymes to assist the working of every cell in our body. These vitamins are involved in the synthesis of new cells as well as in the metabolism of fat, protein and carbohydrates. Vitamin C, due to its antioxidant activity may prevent various diseases by protecting the tissues from oxidative stress [23].

**Amino acids**

Amino acid contents of dates are reduced as they pass through different maturation stages that is due to reduction in its water content [24]. Dates contain very small amount of protein, so these are not considered its important nutritional source. However, there are some essential amino acids in dates which the human body cannot synthesize and must be supplied in the diet. Predominant amino acids in fresh dates are glycine, leucine, lysine, aspartic and glutamic acid while proline, leucine, glycine, aspartic and glutamic acid are dominant in dried date fruits.

**Dietary fiber**

Several studies have revealed that major dietary fiber in dates is insoluble. There was an increase in dietary fiber from 7.5 g/100g to 8 g/100g as dates move from fresh to dried stage during the ripening process. This increase either may be due to reduction in moisture content or enzymatic break down of substances into soluble compounds [25]. On the average, date fruit contains 0.84g/100g soluble dietary fibre, 5.76 g/100g insoluble dietary fiber and 8 g/100g total dietary fiber [1, 9, 12, 26, 27].

Recommended daily intake (RDI) of dietary fiber is about 25 g/day [28]. Dates are a good source of dietary fiber because 100g of dates can provide about 32% RDI of dietary fiber. Insoluble dietary fiber plays a very significant physiological role in our body. It can protect our body from various diseases like diverticular disease and bowel cancer by increasing stool weight and thus has a laxative effect [28].

**Carotenoids**

Lutein, neoxanthin and β-carotene are the dominant carotenoids in dates. On the average, total carotenoid contents of fresh and dried dates are 913 and 973 $\mu$g/100g of dates respectively [1, 29-31].

Several factors affect the carotenoid contents of dates like drying method, analysis conditions, and variety and maturation stage of dates. Date fruits that are red in color usually have hydrocarbon carotenoids like gamma-carotene, neurosporene and lycopene. Yellow coloured date varieties contain a mixture of carotenol fatty acid esters in addition to other carotenoids [25]. Carotenoids can be degraded or isomerized to form *cis* isomers of carotene during drying process. The rate of carotene degradation or isomerization is dependent on drying temperature and duration [1, 29].

**Anthocyanin, phenolics and antioxidants**

Anthocyanins are the compounds that are present only in fresh dates especially that are red in colour. On the average, dates contain about 0.87 mg anthocyanins per 100 g of dates. Anthocyanins usually destroyed in dried dates during drying process [1, 4, 32]. Some other factors, like storage conditions, light, agronomic factors and genetics may affect anthocyanin concentration [33].

Phenolic contents of fresh and dried dates are 193.7 mg/100g and 239.5 mg/100g respectively. Oxidative decomposition of phenolics may resulted enzymatically (via polyphenol oxidase and glycosidase) or thermally during dates drying [33]. However there is an increase in phenolics in some varieties that is possibly due to the breakdown of tannins during the drying process and releases the phenolic compounds [4].

Oxygen Radical Absorbance Capacity (ORAC), DiPhenyl-l-PicrylHydrazyl (DPPH) and Ferric Reducing Ability of Plasma (FRAP) are some important methods used to determine antioxidant contents of dates. On the average, antioxidant contents of dates determine by ORAC method was 1656 $\mu$mol trolox/100g and 1025 $\mu$mol trolox/100g in fresh and dried dates [1]. This clearly shows that there is a decrease in antioxidant

contents of dates during drying process that may be due to its decomposition.

## Health importance of dates

It is believed that natural antioxidants present in dates are helpful to activate both enzymatic as well as non-enzymatic antioxidant system [34]. Fruits and vegetables are an important source of these dietary antioxidants and epidemiological studies showed that their regular intake in diet may decrease the risk of several chronic diseases like diabetes, cancer and cardiovascular diseases [35, 36]. Antioxidants present in dates are glutathione, poyamines and phenolics. Among the phenolics present in dates are hydroxycinnamates, phenolic acids and flavonoids. In this way, date consumption may contribute towards the management of these degenerative diseases.

The Major antioxidant activity of dates is due to phenolics. Biological effects caused by phenolics can be categorized into two main groups. First one is the prevention of lipids, nucleic acids and proteins from oxidative damage by acting as a free radical scavenger [4, 37, 38]. Second one is its ability to modulate the cell physiology by physiologically or biochemically.

From ancient times, date has been used in several medicines to treat diseases like hypertension, diabetes, cancer [39], atherosclerosis [40] and as an antibacterial [41], antifungal and immune-modulator [42]. Dietary antioxidants in dates help to protect the body from various degenerative disorders like neurological, cardiovascular diseases and ulcer [43, 44] and gastric ulcer by minimizing oxidative stress [45].

## Antimicrobial properties

Dates, due to their high phenolic contents are found to have anti-fungal, anti -bacterial and anti – viral properties and prevent chronic inflammation and other certain diseases. Dates are also rich in ascorbate, carotenoids, selenium and other antioxidants that may protect the body from oxidative damage caused by the lymphocyte phagocytosis activity of pests and pathogens.

## Anti-tumoral and anti-ulcer properties

Most of the phenolics that have proved anti-carcinogenic activity are present abundantly in dates [46, 47]. It is believed that phenolics interfere the formation of malignant tumors at different stages [48]. The anti-cancer activity of phenolics may be due to their ability to inactivate the enzymes that catalyzes the formation of pro-carcinogens or due to their anti-mutagen activity [4, 49].

Caffeic and ferulic acids are the main phenolic acids in dates and inhibit the development of skin tumors because they react with nitriles and prevent the formation of nitrosamines [50]. Phenolics, in addition to their role in preventing oxidation mediated damages have also proven their ability to minimize the occurrence of infectious diseases.

Yoshida et al. [51] conducted an experiment on rats to check the effect of quercetin that is commonly present flavonoid in dates on cell growth of malignant cells derived from human gastro-intestinal tract. He found that the growth of gastric cancer cells was inhibited noticeably by quercetin. It can also suppress the synthesis of 14% DNA and also block the cell progression from G1 to S phase. Al-Qarawi et al. [45] used ethanolic and aqueous extract of dates on rats suffered from gastric ulcer to test the claim that dates are effective to prevent gastric ulcer. He found that both extracts were effective to decrease the severity of gastric ulcer.

## Immuno-modulatory properties

Dates due to their high fiber and phenolic contents can play a potent role in the prevention of cardiovascular disease and modulation of the immune system. Prevention of cardiovascular disease may be due to inhibition of platelet aggregation as well as oxidation of low density lipoprotein. Phenolics due to their anti-inflammatory and antithrombotic effect may be able to reduce blood pressure [52, 53].

In addition to these benefits, phenolics are also able to manifest in type- II diabetes by inhibiting the activities of α-glucosidase and α-amylase to increase blood glucose level [54, 55]. Phenolics derived from dates are also able to suppress the hypersensitive of immune response due to their anti-allergic immuno-modulatory activities. The immuno-modulatory activities of phenolics also include anti-inflammatory responses triggered by the suppression of pro-inflammatory pathways [56].

## Dates as a functional food and nutraceuticals

To reduce the risk of various diseases as well as to improve the well-being of individuals, there has an increasing trend to identify the food that can serve as both nutraceuticals and functional food. Various important nutritional elements of dates make them a potent source of nutraceuticals and functional food.

A number of studies on the functional properties and composition of dates and their by-products have

been conducted in the last five years [4, 57, 58]. Various compositional studies on dates and their by-product reveal that dates contain substantial amount of total phenolics, vitamins and dietary fiber [1, 9, 12]. This shows that dates are rich in antioxidants and can be used either functional food or as an ingredient in functional food.

Various oxidant by-products are generated in humans due to metabolic activities that can damage our protein, lipid and DNA, which may lead to various degenerative diseases like cataracts, cardiovascular disease, aging, brain dysfunction, cancer and immune system decline. Along with metabolic processes, there are some other factors that can increase oxidative damage like diet deficient in fruits and vegetables, smoking and excess intake of iron and copper. These oxidative damages can be prevented by phenolics and other antioxidants like tocopherols, ascorbate and carotenoids. Dates are a good source of all these antioxidants and that's why their demand as a neutraceutical is increasing day by day.

## Conclusions

This review showed that dates, due to their unique nutritional composition, can serve as an important food in the human diet and can play a major role in human health and nutrition. It also contains a number of functional and bioactive compounds like carotenoids, anthocyanins, phenolics, antioxidants and dietary fiber due to which dates exhibit anti-tumoral, anti-ulcer, anti-microbial as well as immuno-modulatory properties. Moreover, dates are also considered as nutraceutical and functional food. As compared to normal food, a few dates can meet our daily nutrient requirement. For this reason date consumption should be highly recommended.

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