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Health Benefits of date palm: phytochemicals and their functions

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Introduction

Date palm (*Phoenix dactylifera* L.) is widely grown in the hot arid regions mainly in the Middle East and North Africa, and provides nutrition, as a staple food for centuries, food security, and raw material to the food industry. Every part of the date palm is useful. Dates offer useful prospects for fighting hunger and diseases. The world production of dates has increased 2.9 times over 40 years, whereas the world population has doubled. The total world export of dates increased by1.71% over 40 years. It is considered as a tree of life and sometimes as "Bread of Desert". This fruit was highly esteemed by the ancient civilizations more than 5000 years ago. Since the date palm cultivation thrives in the hostile environment, it is clear that secondary metabolites play an important role in conferring a protective effect against high temperature, UV-damage, and tolerance to drought and salinity; proven deleterious to plant pathogens and pests.However systematic studies on the health benefits are inadequate and hardly recognized as a healthy food. In recent years, an explosion of interest in the numerous health benefits of dates has led to many studies, and identification and quantification of various classes of phytochemicals with a great potential uses in the booming industries of functional foods and nutraceuticals. The global market for herbal medicines or plant – based medicines currently stands at over $60 billion annually. The sale of herbal medicines is expected to get higher at 6.4% an average annual growth rate. Even though date fruits are rich in nutrition, minerals, sugar and phytochemicals and its global market share is extremely low. Date fruit needs to be promoted as a health food for infants, youth, healthy adults as well as patients with chronic diseases. Moreover, International trade in plant-based medicine has become a major force in the global economy and the demand is increasing in both developed and developing countries. However, the quality and consistency of the products are most challenging issues facing the plant-based medicines. They are contamination with microbes and soil contaminants such as heavy metals, herbicides, pesticides, and other agricultural chemicals which can cause qualitative and quantitative changes in the levels of medicinal metabolites. Overall production of medicinal metabolites in plants is affected by plant genotype, cultivation, harvesting, processing and distribution. Therefore more research is needed on the phytochemical composition, nutritional value, and potential health benefits of date fruit consumption, e.g. laxative, anti-inflammatory activity, protection against chemical induced toxicity, neuro-protective effects, anti-ulcer, nutrient deficiency for preventing the malnutrition.

Date fruit: a rich source of nutrition

Date fruit is a rich source of sugar, nutrients and pharmaceutical secondary metabolites, and provide 3150 calories per kilogram, and contain a high percentage of carbohydrate (total sugars, 44 88%), fat (0.2 0.5%), 15 salts and minerals, protein (2.3 5.6%), vitamins and a high percentage of dietary fibre (6.4 11.5%). They contain calcium, magnesium, phosphorus, potassium, iron, zinc, copper, manganese, selenium, vitamins A, A1, B, B1, B2, B3, B5, B6, and C as well as a variety of amino acids. The flesh of dates contains 20% moisture, between 50 and 67% sugar, 2.5%, 2% protein and less than 2% each of fat, minerals and pectic substances. Dates also contain thiamine, riboflavin, niacin, and pantothenic acid. These vitamins and minerals help the body produce hemoglobin, which is a protein in red blood cells that binds to oxygen and carries oxygen from the lungs to tissues. Potassium is an essential mineral that the body needs to maintain proper muscle contractions including contractions of the heart muscle. Potassium also promotes a healthy nervous

system and efficient metabolism in the body. Dates also contain carbohydrates that include 3 grams of dietary fiber and 29 grams of naturally occurring sugars such as fructose, glucose, and sucrose. In other words, one serving of date contains 31 grams of carbohydrates that supplies the body with large amounts of energy. Dates in addition to being a good source of dietary fiber are sodium free, fat free, and cholesterol free. Each of these factors is important for reducing the risk of developing heart disease and cancer. The fiber found in dates comes in two forms, soluble and insoluble. Soluble fiber has been shown to help control diabetes by decreasing high blood sugar as well as lowering high cholesterol, specifically low density lipoprotein (LDL) cholesterol. Insoluble fiber increases the body's ability and rate at which food is processed through the digestive system. The flesh of dates contains 0.2 0.5% oil, whereas the seed contains 7.7 9.7% oil. The weight of the seed is 5.6 14.2% of the date. The fatty acids occur in both flesh and seed as a range of saturated and unsaturated acids, the seeds containing 14 types of fatty acids, but only eight of these fatty acids occur in very low concentration in the flesh. Unsaturated fatty acids include palmitoleic, oleic, linoleic and linolenic acids. The oleic acid content of the seeds varies from 41.1 to 58.8%, which suggests that the seeds of date could be used as a source of oleic acid. There are at least 15 minerals in dates. The percentage of each mineral in dried dates varies from 0.1 to 916 mg/100 g date depending on the type of mineral. Other minerals and salts that are found in various proportions include boron, potassium, phosphorous, sodium and zinc. Additionally, the seeds contain aluminum, cadmium, chloride, lead and sulphur in various proportions. Dates contain elemental fluorine that is useful in protecting teeth against decay. Selenium, another element believed to help prevent cancer and important in immune function, is also found in dates. The protein in dates contains 23 types of amino acids, some of which are not present in the most popular fruits such as oranges, apples and bananas. Dates contain at least six vitamins including a small amount of vitamin C, and vitamins B thiamine, B riboflavin, nicotinic acid (niacin) and vitamin A. The dietary fibre of 14 varieties of dates has been shown to be as high as 6.4 11.5% depending on variety and degree of ripeness. Dates contain 0.5 3.9% pectin, which may have important health benefits. In many ways, dates may be considered as an almost ideal food, providing a wide range of essential nutrients and potential health benefits.

Phytochemicals of date fruits

The protective effects of fruits against chronic diseases are attributed to bioactive non-nutrients called phytochemicals, which are together with secondary plant metabolites or integral cellular components. Phytochemicals have gained increased interest among researchers and clinicians due to their antioxidant activity, cholesterol-lowering properties, and other potential health benefits such as chemoprevention of cancer, prevention of diabetes, and cardiovascular diseases. Date fruits contain many classes of bioactive components including carotenoids, polyphenols especially phenolic acid, isoflavons, lignins, and flavonoids, tannins, and sterols. However, studies on the detailed identification, characterization, and quantification of phytochemicals in different date varieties at different stages of fruit ripening are still insufficient. The quantity and composition of the phytochemicals present in date fruits vary widely depending on the date variety, stage of maturation, storage, postharvest processing, extent of hydration, experimental conditions for the analysis, and the geographical origin of dates. Several reports have indicated that sun drying of date fruits significantly loses total carotenoids (up to 30%) and anthocyanin (93%) and increases total polyphenols (22-153%) and phenolic acids (64-107%). Date fruit is a rich source of pharmaceutical secondary metabolites such as phenolic, citric acid, oxytetracycline and ethanol as well as essential oils, polyphenols and dietary fibers. The phenolic compounds, hydroxycinnamates, Gallic acid derivatives, monohydroxybenzoic acids, flavones and anthocyanin are widely distributed in date palm. The antioxidant activity of date palm has been attributed to phenolic compounds. The major carotenoid pigments are lutein and β-carotene. Provitamin a value also varied with cultivar and

ripening stage. Studies on the saturated fatty acids in the flesh and seeds of dates revealed the presence of saturated fatty acids, including capric, lauric, myristic, palmitic, stearic, margaric, arachidic, heneicosanoic, behenic and tricosanoic acids. Unsaturated fatty acids included palmitoleic, oleic, linoleic and linolenic acids. Alpha-tocopherol (vitamin E) is often used orally to treat deficiencies, and in preventing cardiovascular diseases, diabetes and its complications, and benign prostatic hyperplasia. This vitamin is also administered against angina, thrombophlebitis, intermittent claudication, hypertension, and to prevent ischemia-reperfusion injury after coronary artery bypass surgery. Alpha-tocopherol reduces the risks of various cancers, Alzheimer's, and Parkinson's diseases and other dementias. Vitamin E is also used against allergies, asthma and other respiratory problems, as well as digestive or circulatory diseases. Additionally, vitamin E is used topically against dermatitis, aging skin, preventing skin ulceration often caused as a consequence of chemotherapeutic drugs.

Phytosterols are metabolites structurally related to steroids, which are widely distributed in animals and plants. Steroids belong to a large group of compounds known as terpenoids or isoprenoids. In date palm cultivars, phytosterols are in abundance in shoot tips and pollen grainsas well as in calli and somatic embryo. The lowest contents were detected in germinating embryos and leaves of cv. Zaghloul, as well as in the leaves of cv. Sewi. Overall, cv. Zaghloul was richer in phytosterols than Sewi regardless of the tissue tested. Among the tissue tested for phytosterols, pollen was the richest and roots the poorest. Analysis using thin layer chromatography revealed a number of phytosterols including cholesterol, beta-sitosterol and stigmasterol, especially in the pollen grains. Phytosterols are beneficial in lowering the blood levels of low-density lipoprotein LDL, the so-called *bad* cholesterol; involved in blocking the absorption of dietary cholesterol into the bloodstream and in inhibiting the reabsorption of cholesterol from bile acids in the digestive process, thus reducing the amount of cholesterol returned to the bloodstream; helpful as anti-inflammatory, anti-atherogenicity, and anti-cancer potential.

Date palm health benefits

Date palm trees have been growing for the last 5000 years in harshest climatic condition and feeding people as source of energy, nutrition security, and as a healthy fruit. There are several following health benefits of date fruits-

1. Fresh dates compose of soft, easily digestible flesh and simple sugars like fructose and dextrose. When eaten, they replenish energy and revitalize the body instantly.
2. Its richness in dietary fiber prevents LDL cholesterol absorption in the gut as well as works as a bulk laxative and that helps to protect the colon mucous membrane by decreasing exposure time and as well as binding to cancer-causing chemicals in the colon.
3. Health benefiting flavonoid polyphenolic antioxidants, known as **tannins**, possess anti-infective, anti-inflammatory, and anti-hemorrhagic (prevent easy bleeding tendencies) properties.
4. Moderate sources of vitamin **A,** known to have antioxidant properties and essential for vision well as maintain healthy mucus membranes and skin. Consumption of natural fruits rich in vitamin A is known to help to protect from lung and oral cavity cancers.
5. Antioxidant flavonoids such as ß-carotene, lutein, and zea-xanthin have the ability to protect cells and other structures in the body from harmful effects of oxygen-free radicals. Thus, eating dates found to offer some protection from colon, prostate, breast, endometrial, lung, and pancreatic cancers. Zea-xanthin protects against age-related macular degeneration, especially in elderly populations. Dates also have the unique distinction of being the only food to contain flavonoid sulphates.
6. Source of iron and being a component of hemoglobin inside the red blood cells, determines the oxygen-carrying capacity of the blood.

7. Excellent source of potassium is an important component of cell and body fluids that help controlling heart rate and blood pressure and thus protect against stroke and coronary heart diseases.
8. Calcium is an important mineral that is an essential constituent of bone and teeth, and required by the body for muscle contraction, blood clotting, and nerve impulse conduction. Manganese is used by the body as a co-factor for the antioxidant enzyme, superoxide dismutase. Copper is required for the production of red blood cells. Magnesium is essential for bone growth.
9. The fruit has adequate levels of B-complex group of vitamins and vitamin K. It contains very good amounts of pyridoxine (vitamin B-6), niacin, pantothenic acid, and riboflavin. These vitamins are acting as cofactors help body metabolize carbohydrates, protein, and fats. Vitamin K is essential for many coagulant factors in the blood as well as in bone metabolism.
10. *Gastrointestinal Protection***:** Feeding rats with aqueous and ethanol extracts of dates and date pits have been observed to cause a concentration-dependent increase in gastrointestinal transit time. These observations lead to believe to the ethno-medicinal claim that dates may be useful to humans with gastric ulcers and also as a natural laxative.
11. *Anti-cancerous***:** This shows that the glucans prepared from the date fruit possess antineoplastic effects in experimental system of study.
12. *Anti-inflammation***:** Oral administration of the methanol and aqueous extracts of edible portion of date fruits suppressed the swelling in the foot significantly by 67.8 and 61.3% respectively, while the methanol extracts of date seeds showed significant reduction by 35.5% in adjuvant arthritis in rats
13. *Antihyperlipidemic***:** Coronary heart disease is related to decrease in the concentrations of high-density lipoprotein cholesterol and increase in the low-density lipoprotein cholesterol. It was reported that feeding the defatted date seed flour containing diet at 1.5%, 2.5% and 5.2% to rats reduced the plasma triglycerides, total cholesterol and low-density lipoprotein.
14. *Immunostimulation***:** Immune activation is an effective and protective approach against infectious diseases. Immunostimulants enhance the overall immunity of the host, and present a non-specific immune response against the microbial pathogens. They also heighten humoral and cellular mediated immune responses
15. *Anti-diarrhea***:** Date spathe aqueous extract at doses of 3, 6 and 12 mg/kg produced a statistically significant reduction in both castor oil induced intestinal transit and frequency of diarrhea in rat. These properties may explain the rationale for the effective use of the plant as an antidiarrheal agent in traditional medicine.
16. *Dietary Fibre*: The good nutritional value of date seeds is based on their dietary fibre content, which makes them suitable for the preparation of fibre-based foods and dietary supplements. Since a large quantity of date seeds are being produced as a waste material and the seeds contain a significant amount of bioactive phenolic and dietary fibre.

Therapeutic uses of different parts of dates

Fruit - Sweet, cooling, tonic, fattening, aphrodisiac, useful in leprosy, thirst, asthma, bronchitis, fatigue, tuberculosis, abdominal complaints, fever, vomiting, loss of consciousness
Leaf - Aphrodisiac and good for the liver
Flower- Bitter, purgative, expectorant, tonic to the liver, fever and blood complaints
Seed - Applied to wounds, lesions, inflammation; it is demulcent, expectorant, laxative, nutrient and prescribed in the case of asthma, gonorrhea
Gum - Useful remedy in diarrhea and disease of the genitor-urinary system

Recent studies have shown for the first time the *in vivo* hepatoprotective and the ant oxidative effects of different varieties of palm date fruits in relation to their total phenolic content**s** and total flavonoids. These results recommend to increase the consumption of palm date fruits, especially in cases of liver diseases and for the prevention of other serious diseases such as cardiovascular and cancers.

A study carried out first time on in vivo effect of Medjool or Hallawi date consumption by healthy subjects on serum glucose, lipids, and oxidative stress. After consumption of Medjool or Hallawi dates, fasting serum glucose and triacylglycerol levels did not increased and serum triacylglycerol levels even significantly ($p < 0.05$) decreased, by 8 or 15%.The study concluded that the date consumption by healthy subjects, despite their high sugar content, demonstrates beneficial effects on serum triacylglycerol and oxidative stress and does not worsen serum glucose and lipid/lipoprotein patterns, and thus can be considered an antiatherogenic (prevent abnormal fatty deposit which develops within the walls of arteries) nutrient.

Diabetes mellitus is a chronic metabolic disorder that leads to long-term complications affecting some tissues such as heart, kidney, retina, and peripheral nerves. Peripheral neuropathy is one of the most frequent and potentially severe complications of diabetes, leading to pain, skin ulcers, muscle weakness, loss of independence, and overall impairment of the patient's quality of life. Recent study on the effects of an aqueous extract of date fruit (*Phoenix dactylifera* L. Arecaceae) diet on diabetic polyneuropathy (DPN) in streptozotocin- (STZ-) induced diabetic rats. Date fruit extract treatment showed efficacy for preventing diabetic deterioration and for improving pathological parameters of diabetic neuropathy in rats, as compared with control groups. Another study showed that low glycemic indices for the five types of dates and that their consumption by diabetic individuals, and does not result in significant postprandial glucose excursions. These findings point to the potential benefits of dates for diabetic subjects when used in a healthy balanced diet.

Additional potential health benefits

Fresh date fruits are an excellent remedy for alcoholic intoxication by soaking in water for a quick relief. They are excellent source of nutrition and sugar, makes ideal to reduce obesity by minimizing food intake urge. Dates stimulate the uterus by regulating contractions which facilitate delivery. The uterus is a relatively large muscular organ and it urgently requires an adequate supply of natural sugar during labour and delivery. Dates contain natural sugar which is easily absorbed and digested, thus, it is safe and comforting for children's stomach and intestine. Dates are also highly beneficial in the treatment of constipation as the roughage provided by it stimulates sluggish bowels Date syrup can be used as a treatment for weak heart. It can also be used for the treatment of sexual weakness. When it's mixed with milk and honey, dates can be used as a tonic for the treatment of sexual disturbances for both sexes.

Recommendations

1. Develop metabolomics system for the identification of metabolites useful for the pharmaceuticals, nutraceuticals, cosmetics, and food industry
2. Date palm seems to be resistant to viruses, and identify compounds for this trait and may be useful for health.
3. Develop proteomic system for analyzing proteins that could be beneficial.
4. Develop nanotechnology for drug production and delivery
5. Develop capsules of dried date fruits as a source of nutrition and energy pills
6. In depth research is needed on date palm useful in curing cancer, diabetics, anti-diarrhea **etc.**