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Evaluation of the biological activities of date seeds

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Dedications

At the end of all these years of study, I dedicate this modest work as a sign of respect and thanks to those who gave meaning to my existence, who supported me night and day throughout my career: my family.

To you dear parents, my sister Yasmina and my brother Fawzy.

I say thank you so much for your support, I am very grateful to you, your pride in my regard today is for me the best reward.

May Allah keep you for me.

To myself that I'm really proud of .





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Abbreviations List

ADF: Acid Detergent Fiber.

BC: Before Christ.

BHA: Butylated hydroxyl anisole.

BHT: Butylated hydroxyl Toluene.

COVID-19: Corona virus disease.

COX: Cyclo oxygenase.

Ha: Hectare.

Mt: Metre.

CPIV : Comité international permanent du vinaigre.

DNA: Deoxyribonucleic Acid.

DF: Dietary Fiber.

DPDRUD : Date palm development unit departement.

DPTCL : Date palm tissu culture laboratory.

DW: Dry weight.

e.g: Exempli gratia.

FAO: Food and Agriculture Organization.

H₂O₂: Hydrogen Peroxide.

IL: Interleukin.

MB: Mythelene bleu.

MENA: Middle East and North Africa.

NDF: Neutral Detergent Fiber.

PG: Propyl gallate.

PGE-2: Prostaglandin E2.

PHB: Poly-3-hydroxy butylate.

SAR:Structure Activity Relationship.

Syn: Synonym.

TBHQ:Tertiary butyl hydro quinone.

UAE:United Arab Emirates.

UV:Ultraviolet.

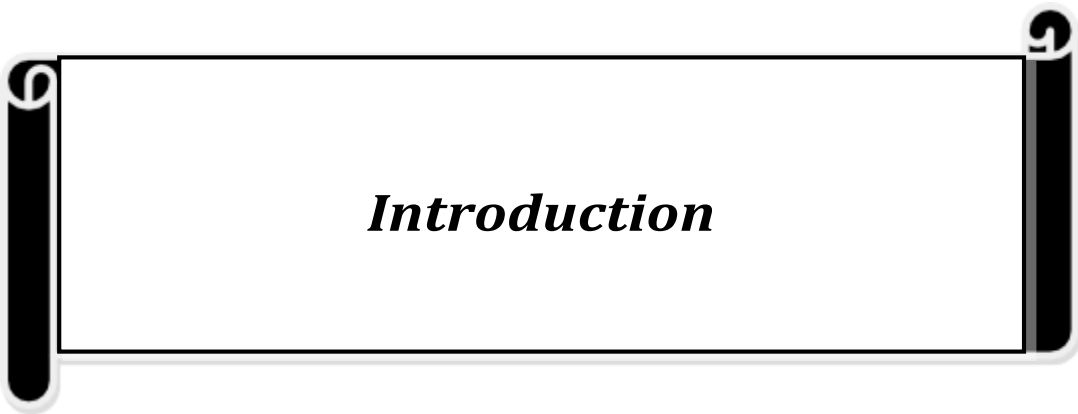
WHO: World Health Organization.

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Introduction

Introduction

Several agricultural and agro-industrial by-products are produced during the production or processing of fruits and vegetable crops, which may cause environmental pollution (**Attia et al., 2021**). On the other hand, over the years, enormous population growth has been reported and it has simultaneously resulted to increased demand for good health as well as wellness promoting fruits. This has culminated in expansive scientific studies on the bioactivity, nutraceutical properties and health benefits of fruits and their wastes (**Idowu et al., 2020**).

Some of the results obtained from those studies indicated a symbiotic positive link between healthy eating of natural products and reduction in death rate due to heart-related, cancer and other deteriorating illness. This was attributed to bioactive compounds, dietary fiber and antioxidants they possess (**Idowu et al., 2020**).

It is also substantial to point out that the demand and price of feed/feed stuff was greatly altered after the COVID-19 crisis, showing great interest on depends on local products and a decrease in the imported ones. These by- products were of great interest during the COVID-19 crisis due to lockdown, close of dry borders, ports and traffic restrictions. The use of alternative feedstuff and locally available feed ingredients would be a possible solution (**Attia et al., 2021**).

Date palm (*Phoenix dactylifera* L.) is a fruit bearing tree with a lot of prospects. It is originating from the Arabian Peninsula, North Africa, and the Middle East. The worldwide production, utilization and industrialization of dates are increasing continuously. Its fruits and seeds otherwise known as pits are considered as a potential source of nutritional and medicinal constituents. It is a rich and cheap source of carbohydrates, proteins, amino acids, minerals (selenium, potassium, calcium, magnesium, manganese, and iron), dietary fiber, vitamins, carotenoids, and fatty acids (**Hussain et al., 2019**).

Date palm is the axis of Algerian Saharan oasis agriculture creating a microclimate suitable for the cultivation of fruit trees, cereal crops, and vegetables. Approximately 18 million date palms are cultivated on an area of 169,380 ha; out of these, ten million trees are producing an annual yield of 500,000 mt of dates.

It is the main crop of both traditional and modern Algerian Saharan agriculture. The economy of the southern provinces (*wilayates*) is based primarily on date palm cultivation and utilization of its fruit by-products such as paste, flour, syrup, vinegar, alcohol, yeast, and

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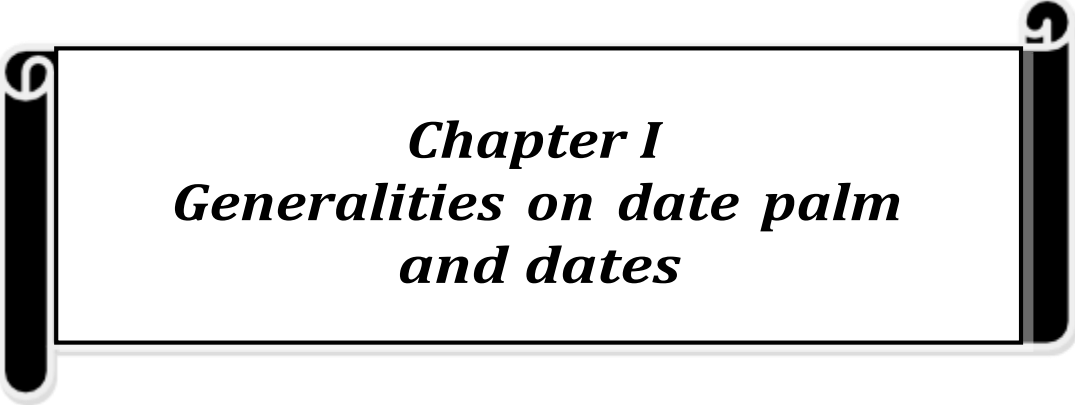
confectionery. This provides a major source of income for oasis inhabitants (**Bouguedoura et al., 2012**).

In addition, date flesh and pits are an important source of different phytochemicals such as flavonoids, phenolic acids, anthocyanins, tannins, and carotenoids. It is well known that the seeds, stones, and pits of several fruits are used as complementary medicine because of their phytochemical nature that helps to prevent sickness, cure the disease, reduce the side effects, and different kind of stresses (**Hussain et al., 2019**).

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Date by-products are the best-known by-products that are produced from the arid and desert regions, which are sometimes used in livestock and poultry diets (**Attia et al., 2021**). Several reports on date pits showed their functional food properties in dietary treatment, macro- and micronutrients and phenolic acids were used as bread ingredients for protein solubility (**Hussain et al., 2019**).

Our study is a review of the literature which brings together the work research up-to-date relating to seeds data; their composition, health benefits and biological activities. Showing how valuable and important they have on our health.



Chapter I
Generalities on date palm
and dates

I.1 Date palm

I.1.1. Presentation of date palm

Phoenix dactylifera L. (Date palm) is an angiosperm monocotyledonous plant belonging to the Arecaceae family (syn. Palmaceae). The genus *Phoenix* contains 12 of the 1500 species that belong to the date palm family. Etymologically, the word “Phoenix” is coined from the Phoenicians who were part of the first to characterize this plant on their trips. *Dactylifera* is coined from *dactylus* which means “date” from Greek word *dactylos*, and *fero* for “date bearing” (Al-Yahyai, 2012).

Phoenix palms are dioeciously and characterized by pinnate leaves and in duplicate leaflets with acute tips (Figure 1) (Al-Yahyai, 2012). It is considered as one of the oldest cultivated fruit trees. It is believed to be indigenous to the countries of the Middle East since at least 6,000 BC (Jenny et al., 2019).

For inhabitants of cooler climates today, palms symbolize the tropics and vacation. The date palm has long been one of the most important fruit crops for southern Mediterranean countries, where dates are the main income source and staple food for some local populations (Anonymous 1).

In addition, this crop is not only a source of income from an economic point of view, but also a key for fixing populations and creating or maintaining centers of life.



Figure 1: Date palm photography (Anonymous 2).

The botanical classification of *Phoenix dactylifera* L. is given in table 1.

Table I: Botanical description of date palm (Khatri, 2015).

Rank	Scientific Name & (Common Name)
Kingdom	Plantae (Plants)
Subkingdom	Tracheobionta (Vascular plants)
Superdivision	Spermatophyta (Seed plants)
Division	Magnoliophyta (Flowering plants)
Class	Liliopsida (Monocotyledons)
Subclass	Arecidae
Order	Arecales
Family	Arecaceae/Palmae (Palm family)
Genus	<i>Phoenix</i> L. (Date palm)
Species	<i>Phoenix dactylifera</i> L. (Date palm)

The date palm tree that has been in cultivation since 2400 BC and was praised and cherished as is evident from the drawings and sculptures of ancient civilizations of the Sumerians, Assyrians, Babylonians, and Egyptians, and later by the Greeks and the Romans that inhabited the Mediterranean basin where date palm and other *Phoenix* species are also commonly grown (Pruessner, 1920).

Date palm still carries great religious significance in all three major religions of the world. In Islam, date palm is cited 21 times in the Holy Quran and 300 times in the Hadith of the Prophet Mohammed, making it by far the most frequently cited plant. Similarly, date palm is praised in Christian and Judaism faiths and has been linked to numerous religious ceremonies such as Passover and Palm Sunday (Musselman, 2007).

Almost un-recognizable in its natural state, the surface and proportion of the date palm has been shaped by man for thousands of years. In its uncultivated form, it is a multi-stemmed plant, not the tall, branchless tree commonly recognized throughout the world (Veillon, 2015).

I.1.2. Reproduction

In ancient myths and fables, date palms are personified and often assume male or female gender roles. These stories portray the trees as social, sentient beings, affected by environmental factors in the same ways as their human counterparts. Because the date palm is dioecious (it is either male or female), its reproductive process is a carefully choreographed event: the male date palm matures first, and has flowers that produce pollen, while female date palms have flowers that bear fruit if pollinated (**Veillon, 2015**).

The flower clusters (inflorescence) of each are housed in soft, long green shields called spathes which turn tough and fibrous at the end of the reproduction cycle, causing them to split open to expose the flowers within (**Veillon, 2015**).

The tree has been genetically engineered for several thousand years. While wind pollination is possible since at least the second millennium BC date palm reproduction has been aided by human intervention to increase the quality and quantity of fruit production, as flowers on female trees must receive pollen within two days of blooming (**Veillon, 2015**).

Traditionally, farmers climb trees and sprinkle the pollen on the female flowers, or tie a flowering male branch inside the blooming female cluster. While manual or natural pollination produces dates, actual reproduction through seeds is extremely rare and typically undesirable for agriculture. Both in ancient times and today, the most common form of reproduction is the separation and use of offshoots of “known producers”. This method creates identical clones of a female plant ensuring female offspring with the same favorable traits (**Veillon, 2015**).

In 1993, the Date Palm Tissue Culture Laboratory (DPTCL) was established in the Date Palm Development Research Unit Department (DPDRUD), at the UAE University, Al Ain. This laboratory, which houses a gene bank of over 100 date palm varieties, is responsible for introducing date palm reproduction through tissue culture, the most common method of propagation today. In this form of reproduction, small amounts of tissue from the heart of palm are grown in a sterile growth medium. Each culture produces its own root, stem and leaf system and is transplanted into boxes and grown in greenhouses. These plants are guaranteed to be pest free and mature more quickly, producing fruit sooner than other methods of propagation (**Veillon, 2015**).

I.1.3. Anatomy

Roots: Date palm has a fasciculated fibrous root system that originates from a bulb at the trunk base. The primary roots have an average length of 4 m and may extend to 10 m in light soils. Primary roots give rise to secondary roots that further branch to form tertiary roots that are shorter in length and diameter. Primary roots originate from seeds but may also continue to grow if date palm is grown from an offshoot or a tissue-cultured seedling (Figure 2) (Al-Yahyai, 2012).

Trunk: The trunk or stripe of date palm is a single, vertical cylinder of equal diameter (average 1 m) throughout its length that can reach 30 m. The stem is covered with leaf bases that are enclosed in fiber, an evolutionary mechanism to protect the trunk from herbivorous insects and animals, as well as an insulation to reduce water loss. Water and nutrients are translocated via vascular tissue composed of tightly-stacked vascular bundles. The stem grows vertically at the terminal bud (phyllophor or phyllogen) and laterally via the fascicular cambium (Figure 2) (Al-Yahyai, 2012).

Leaves: Date palm leaves, called fronds, are pinnate, compound leaves spirally arranged around the trunk. The fully mature leaf is 4 m long, but ranges from 3 to 6 m, and is 0.5 m wide at the middle midrib that narrows toward both leaf ends. The date palm leaf is divided into three regions: the petiole, the spinal region that transitions into the blade region that is held by a geometrically shaped midrib. Angular leaflets are distributed in the blade region. The number of leaves produced annually varies from 10 to 26 and a mature palm may have from 100 to 125 leaves; 50% of them are photosynthetically active. Leaves remain attached to the tree following their senescence and have to be manually pruned (Figure 2) (Al-Yahyai, 2012).

Flowers: Date palm is a dioecious plant where pistillate and staminate flowers are born on separate plants. Male and female flowers are arranged in strands that attach to a rachis forming an inflorescence called spadix. A bract, called spathe, enclosing the immature inflorescence, splits longitudinally at anthesis (Figure 2), which allows for the pollination of mature male and female flowers (Al-Yahyai, 2012).

Fruits: Fruits of date palm, called dates, develop from one fertilized ovule forming one carpel. The date fruit develops on the flowering strands and is a berry characterized by a

membranous endocarp surrounding a seed. Large variations exist in the shape, size, color, and chemical composition of date fruit, depending largely on varietal differences but also on climate, soil, and growing conditions. Similarly, date seeds vary in size and shape, but they are generally ventrally grooved, oblong, and range from 5 to 15 mm with an embryo born in the middle of the seed that is surrounded by the endosperm (Figure 2) (Al-Yahyai, 2012).

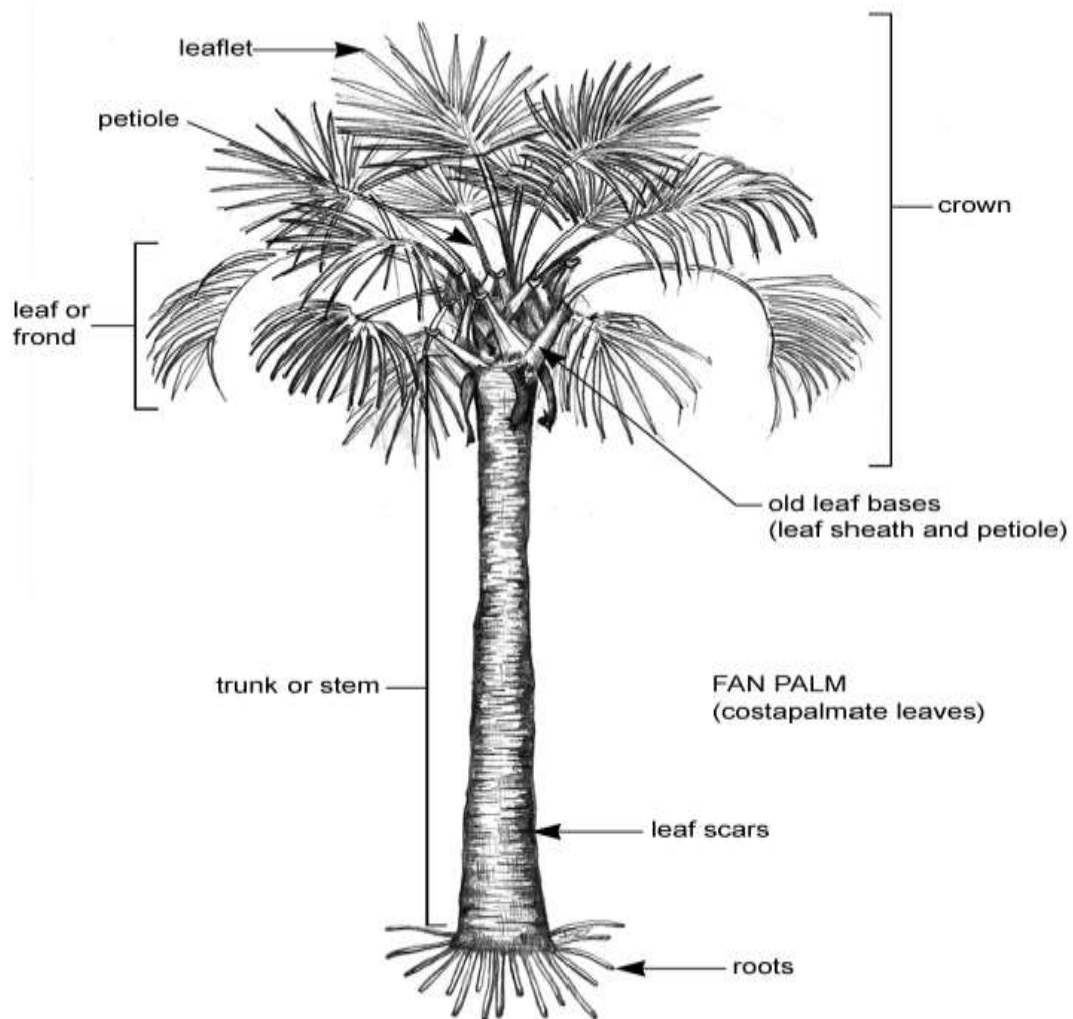


Figure 2: Date palm tree anatomy (Al-Yahyai, 2012).

I.1.4. Palm trees importance

One of the most important and most abstract by-products of date palm cultivation is the shade it produces. The plants provide protection from the harsh desert sun and winds to humans, animals and crops by creating a temperate microclimate more suitable for sustaining life, while also reducing the damage caused by sandstorms and wind erosion (Veillon, 2015).

Under the canopy of the date palm oases, often fed by an underground water source (falaj), other crops such as citrus trees, alfalfa, watermelon, sweet potatoes and beans, cotton,

wheat, barley and millet can flourish and animals, such as cattle, sheep and goats, can graze. Planted adjacent to houses, the palms provided shade for human and animal settlement and air filtration in a dusty, desert landscape (Veillon, 2015).

In addition to the shade produced by the date palms, buildings constructed from date palm materials provide ventilation, and can reduce the interior temperature by 30 degrees. Woven window coverings made from palm leaves reduce solar penetration and filter dust and dirt out of the air. Small fibers protruding from the surface of each frond are able to trap the unwanted particles more efficiently than modern synthetic materials (Veillon, 2015).

I.1.5. Cultivation and usage

Date palm thrives in areas characterized by hot, low humidity, particularly during fruit development. Moisture adversely affects the quality of fruit, as high humidity leads to fruit cracking and checking. Date palm can be planted in a wide range of soils with varying amounts of organic and mineral nutrients. Date palm is known to tolerate salinity and the drought more than any other cultivated fruit crop (Al-Yahyai, 2012).

Many parts of the world where date palm is grown still follow the traditional mixed planting of dates of various ages at irregular spacing. Moreover, inadequate fertilizer application and lack of proper tree and bunch management, such as pruning and fruit thinning, lead to the production of low fruit quality and thus lower market values (Al-Yahyai, 2012).

The development of a tissue culture technique for the mass propagation of date palm plants has expanded the date palm industry. Substantial advantages are gained from this technique such as a better production rate, greater strength, freedom from pests and diseases, and wider availability of valuable varieties (Al-Farsi et al., 2011).

At present, seeds are still used mainly for animal feed but some applications have also been noted in the food and other areas. So, a coffee-like product is made from date seeds by drying, roasting, and grinding them in a similar way to coffee beans, to produce caffeine-free coffee. Otherwise, date seed oil has been used to replace the portions of other vegetable oils in body creams, shampoos, and shaving soap formulations, and, in general, the quality of these cosmetic formulations is encouraging (Al-Farsi et al., 2011).

I.1.6. Geographical distribution

It is said that the date palm is happiest when its “feet are in water and its head is in heaven’s fire,” making the Arabian Desert oasis an optimal home. It is often fed by underground irrigation systems or a natural ground-water source (Veillon, 2015).

Date palms are native to the Canary Islands which are located in the Atlantic Ocean off the coast of northeast Africa. These stately palms are popular landscape items in near frost-free climates around the world (Devshony et al., 1992).

Date palm is a socio-economically and traditionally important crop in the Middle East and North Africa (MENA) (Oladzad et al., 2021), and a major contributor to food security in arid regions of the world (Figure 3).

Beyond the arid climates, date palm can also be grown in many other countries for food or as an ornamental plant including the continents of Americas, southern Europe, Asia, Africa, and Australia (Pruessner, 1920)



Figure 3: Date palm distribution in the world (Anonymous 3).

In Algeria, date palms are cultivated in oases in most of the south regions of the Saharan Atlas Mountains (Figure 4).



Figure 4: Geographical distribution of date palms in Algeria (Anonymous 4).

I.2. Dates

I.2.1. Generalities

The fruit of the date palm is well known as a staple food (Ardekania et al., 2010). The edible part of date fruit is fleshy mesocarp, which exist in-between the epicarp and hard endocarp (an outer fleshy fruit) surrounding a seed (Figure 5) (Metoui et al., 2018). Large variations exist in the shape, size, color, and chemical composition of date fruit, depending largely on varietal differences but also on climate, soil, and growing conditions (Zaid et al., 2002).

Date palms differ from other fruits because they have four botanical phases of development after cultivation (Idowu et al., 2020). In agrarian communities, dates can serve as rich sources of cheap food for the growing population, thereby improving food security (Idowu et al., 2020). Dates have been recognized as an excellent source of energy and healthy nutrition (Ourradia et al., 2022).

Mesocarp of date fruit has more than 80% sugars and the remaining 20% are represented by dietetic fibers, protein, lipids, and ash (Metoui et al., 2018). Most of the carbohydrates in dates are in the form of fructose and glucose, which are easily absorbed by the human body (Ardekania et al., 2010). A date is also a good source of vitamin, minerals (selenium, potassium, calcium, magnesium, manganese, phosphorous, zinc, potassium, iodine and iron) (Hussain et al., 2019).

Besides, date fruits are a rich and cheap source of dietary antioxidants including phenolic compounds and carotenoids which may help to protect the body from various degenerative disorders by minimizing oxidative stress and are related to the therapeutic implications in the control of diseases, through antibacterial, immunomodulatory, antiparasitic, hepatoprotective, anti-inflammatory and anticoccidial activities effects (Hussain et al., 2019).

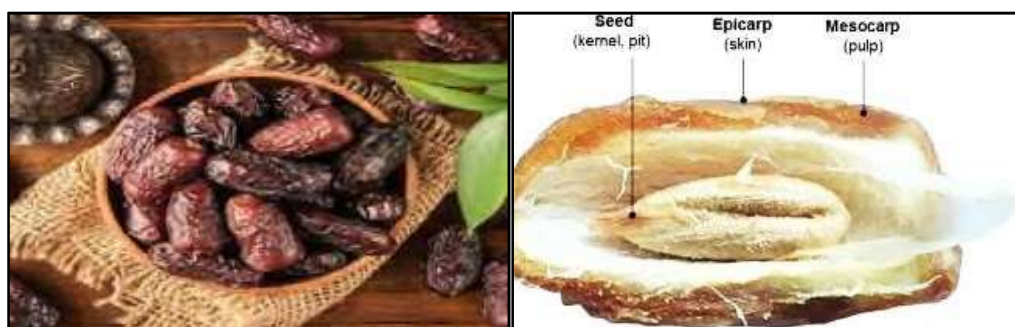


Figure 5: Photography of dates and their botanical organization (Anonymous 5).

I.2.2 Maturity stages

Date fruit development progresses through five maturity stages that take about 6–8 months: first stage: grow rapidly, second stage: turn their characteristic color, third stage: lose water, Fourth stage: accumulate sugars, and fifth stage: ripen completely. These stages are shown in Figure 6; described by Siddiq et al. (2014). The corresponding names and the details regarding each stage are as follow (**Siddiq et al., 2014**):

Hababouk: The first stage that appears after pollination and continues for 4–5 weeks. The fruit has round shape, whitish-cream color with green stripes.

Kimri: This stage appears in the first 17 weeks after pollination. The fruit is young, elongated, greenish in color, hard in texture and with about 85% moisture. Fruit weight increases significantly and the tannin concentration is high. Although the fruit is inedible for direct consumption at this stage, it can be used for making chutney (sauce) or pickles.

Khalal: During the next 6 weeks, date fruit gains maximum size and weight, color gradually becomes a typical yellow, purplish-pink, or red depending on the cultivar, with hard texture. At this stage, sugar increases slowly and becomes mainly sucrose. This is the stage at which dates are mainly consumed raw as fresh fruit or they can be used for jam, butter, or date-in-syrup.

Rutab: In the next 4 weeks, the dates lose water with half of the fruit becoming soft, sweeter and darker in color (light brown), and less astringent. Sucrose converts to reducing sugars and protein, fat and ash percentages decrease. This stage is the start of ripening. Dates at Rutab stage from many cultivars are eaten fresh or processed into jam, butter, date bars, and date paste.

Tamr or Tamar/Tamer: During this final stage, that typically lasts 2 weeks; the fruit gains maximum total solids, highest sweetness, lowest astringency, dark brown color, soft texture, and a typical wrinkled shape. There is a high concentration of reducing sugars, especially glucose and fructose, with no or very low sucrose. The percentages of protein, fat and ash are less compared to Rutab stage. Owing to low moisture and high sugar content, dates of this stage have good storage stability (about one year at room temperature if they are packed tightly). For dry cultivars, Tamr dates become light colored with a dry hard skin, whereas for soft cultivars the flesh remains intact and soft with a dark color.

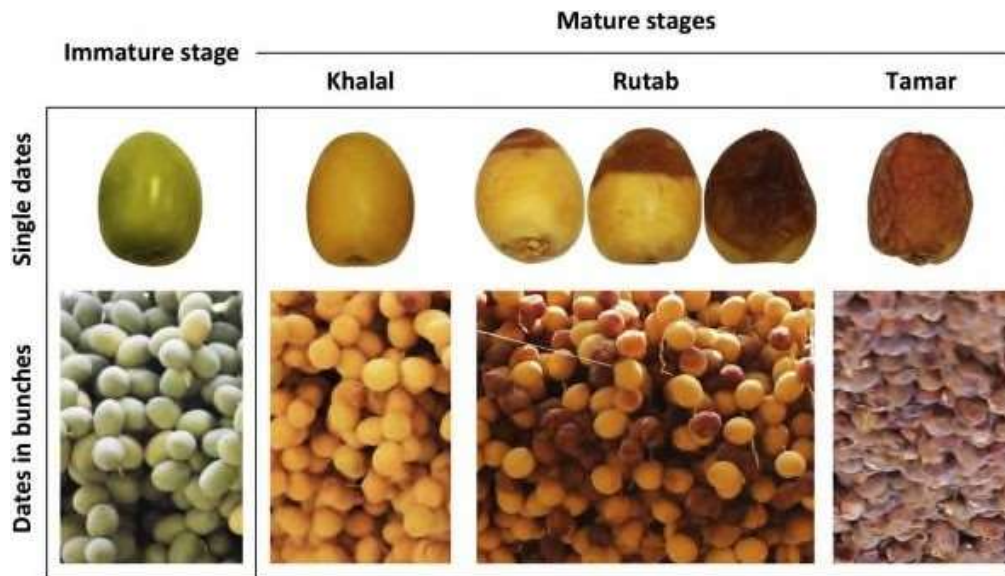


Figure 6: Different growth and maturity stages of date fruit (Siddiq et al., 2014).

I.2.3. World date production

Date fruit is regarded as a pivotal crop that is extensively farmed in the Middle East and Africa, and these regions are responsible for the exportation of date products worldwide (Messaoudi et al, 2013). From records, top five largest dates producer countries are Egypt, Saudi Arabia, Iran, Algeria and Iraq from 1961 to 2020 (Figure 7). In 2020, the global production volume of dates amounted to about 9,45 million metric tons (Shahbandeh, 2022). Date farming in the Mediterranean country is a serious business, with 18 million palm trees producing 500.000 tons per year. In fact, Algeria is the 4th largest producer of dates in the world, with the Deglet Nour dates being the country's top date exports.



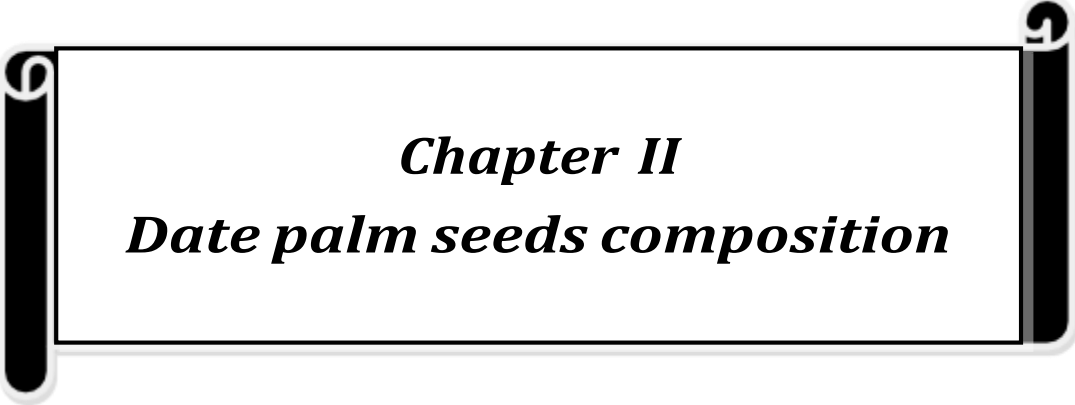
Figure 7: Largest dates producing countries (Anonymous 6).

I.2.4. Date seeds**Description**

Date pits, also called pips, stones, kernels, or seeds colored light brown form part of the integral date fruit (**Barreveld, 1993**) which is a hard oblong body, ventrally grooved, with a small embryo, and with a hard endosperm made of a cellulose deposit on the inside of the cell walls and present in the midst of the date fruit, and its length ranges from 12 to 36 mm, while the width ranges from 6 to 14 mm and they weigh from 0.5 to 4 g (Figure 8). The size and weight of the seeds depend upon the variety, maturity and growing conditions (**Attia et al., 2021**).



Figure 8: photography of date seeds (Anonymous 7).



Chapter II
Date palm seeds composition

II.1. Nutritional components of date seeds

In fact, date pits represent about 10% of the ripened fruit's total fresh weight (Nehdi et al., 2010). They are rich in nutritive substances whose composition depends on the variety and fruit maturation, harvesting time, origin, and the type of fertilizer used (Barreveld, 1993), it has 5–10% moisture, 4–7% protein, 6–12% oil, 1% ash, and 75–81% carbohydrates with sucrose, maltose, glucose and fructose which constitute >80% of its dry matter and mainly dietary fibers (10-20%). Date seeds are as well as rich in macro-elements such as potassium (229–400 mg/100 g), magnesium (51–82 mg/100 g), calcium (28–62 mg/100 g), phosphorus (68–83 mg/100 g), and iron (2–7 mg/100 g) (Ourradi et al., 2021).

The detail concerning the different nutrients is given below:

► Proteins

According to the many studies performed on different date varieties, it appears that glutamic acid, aspartic acid and arginine account for nearly half of total amino acids whilst tryptophan is the most limiting essential amino acid followed by isoleucine, and lysine (Barreveld, 1993).

► Carbohydrates

"Carbohydrates", the largest component, is found as the rest value (i.e. 100 minus the other main components). Only a small part, in order of a few percentages, consists of sugar, the remainder of carbohydrates being of a more complex nature. This part can be further split up in cellulose, hemicellulose, lignin and ash (Barreveld, 1993).

Table 4: date pits carbohydrates composition (Barreveld, 1993).

Carbohydrates	% of dry weight
Neutral Detergent Fiber (NDF)	75.0
Acid Detergent Fiber (ADF)	57.5
Hemicellulose	17.5
Lignin	11.0
Cellulose	42.5
Ash	4.0

· Minerals

Major mineral nutrients in date seed are: potassium (255.43), magnesium (62.78), calcium (48.56) and phosphorus (41.33) (mg/100 g of oil) with a low sodium content. Of the micro elements iron, manganese, zinc *and* copper are the more important ones (**Barreveld, 1993**).

· Dietary fibers content

This is the edible portion of analogous or plants carbohydrate that resist absorption and breakdown in the human small intestine with partial or complete fermentation in the large intestine. Dietary fibers (DF) offers some vital health benefits such as reduction in cholesterol present in the body by reducing low-density lipoprotein, anti-obesity effect, less risk of developing hemorrhoids, enhancement of gut-health and bowels through fecal bulk as well as production of short-chain fatty acids and anti-diabetic property (**Idowu et al., 2021**).

DF also possessed some functional properties such as gel formation, oil/water retention and emulsifying capacities that are applied for novel food development. Different studies have reported that date palm possessed high DF, date seeds in particular, can serve as a rich source of fiber without any negative impact on sensory quality of end-products if the seeds are properly milled (**Idowu et al., 2021**).

· Oil

Date seeds are also a good source of oil, which is rich in phenolic compounds, tocopherols, and phytosterols. Date seed oil has been studied by several authors, and its composition in vitamins, minerals, and fatty acids makes it valuable for food formulations (**Mrabet and al., 2022**).

The oil extracted from date pits is pale yellowish-green with a pleasant odor usually composed of (**Barreveld, 1993**) :

▶ Fatty acids

As shown in Table 6, the fatty acid profile of several date seed oils are characterized by the presence of five major fatty acids, but in different amounts (oleic acid (C18:1), linoleic acid (C18:2), palmitic acid (C16:0), myristic acid (C14:0), and lauric acid (C12:0), which together compose more than 90% of the total fatty acid contents. Some fatty acids were detected in lower amounts, including capric (C10:0), palmitoleic (C16:1), linolenic (C18:3), and gadoleic (C20:1) acids. Date seed oil is a source of saturated (lauric, myristic, and

palmitic acids), mono-unsaturated (palmitoleic and oleic acids), and polyunsaturated (linoleic and linolenic acids) fatty acids at about 50, 43, and 8%, respectively (Mrabet et al., 2020; Besbes et al., 2004; Boukouada et al., 2009).

Generally, the fatty acid composition of date seed oil can change depending on variety and ripening stage, as well as extraction method.

Table 5: Fatty acids profile of date seeds (Mrabet et al., 2022).

Fatty acids	Content (%)
Oleic acid (C18 : 1)	49.72
Lauric acid (C12:0)	13.73
Linoleic acid (C18:2)	20.23
Stearic acid (C18:0)	8.97
Palmatic acid (C16:0)	7.35

Usually, oils with high oleic acid contents are of great interest due to their high stability and their nutritional importance. Oleic acid is recognized as one of the most important unsaturated fatty acids in human food because of its preventive effects on distinct heart vascular and inflammatory diseases, its low saturation level, and its potential for reducing cholesterol in the blood, as well as its high oxidative stability (Kirthy et al., 2017).

Moreover, various studies point out the preventive effect of lauric acid on prostatic hyperplasia development (Veeresh et al., 2010), its healthier characteristics compared to trans-fatty acids (de Roos et al., 2001), and its antimicrobial properties, which inhibit the growth of microbes and their production of toxins (Desbois et al., 2012).

► Tocopherol and tocotrienol compositions

These natural antioxidants vary from one vegetable oil to another. Different forms of tocopherols (α -, β -, γ -, and δ -tocopherols and α -, β -, γ -, and δ -tocotrienols) are found in the main sources of vegetable oil. The predominance of one tocol or another depends on the origin of the oil. The average tocol (tocopherols and tocotrienols) content in date seed oil is 74.1 mg/100 g (Mrabet et al., 2022).

Recent research has characterized the tocol family profiles in date seed oil (Table 6). However, oils from different varieties or origins had different qualitative and quantitative tocol compositions.

Table 6: Date seeds oil tocols composition (Mrabet et al., 2022).

Content (mg/100 g)	Composition
32-74	α -tocopherol (74%), (β + γ)-tocopherol (40.56%), δ -tocopherol (28.41%)
54.65	α -tocotrienol (63.28%), γ -tocopherol (17.72%), γ -tocotrienol (11.84%), δ -tocotrienol (3.60%), α -tocopherol (1.85%), β -tocopherol (1.7%)
0.053-0.143	α -tocopherol (51.02%), (β + γ)-tocopherol (30.61%), δ -tocopherol (12.24%)
1.01-1.86	α -tocopherol (52.54%), α -tocopheryl acetate (27.68%), γ -tocopherol (19.76%)
24.97-42.08	α -tocopherol (38.8%), γ -tocopherol(5.4%), δ -tocopherol(19.76%)
51.54	α -tocotrienol (66%), γ -tocopherol (10.3%), γ -tocotrienol (4.6%), δ -tocopherol (1%), β -tocopherol(0.9%), α -tocopherol (0.6%)
70.75	α -tocotrienol (30.19%), γ -tocopherol (23.61%), γ -tocotrienol (19.07%), α -tocopherol (17.52%), δ -tocotrienol (5.89%), β -tocopherol (2.42%), δ -tocopherol (0.9%).

► Sterols composition

Phytosterols belongs to the class of phytochemicals that are located in the lipid soluble fraction of date fruit. The level of phytosterols in vegetable oils is used for the determination of the oil quality and for detecting alterations. In general, phytosterols are present in oils in their esterified forms. Sterols, along with tocols, have been shown to be major components of the unsaponifiable fraction (Mrabet et al., 2022).

Date seed or pit consist of large proportion of phytosterols and have been applied for years to cure hormone related health challenges. The literature reported that the major components of date seed oil sterols were β -sitosterol, campesterol, and Δ 5-avenasterol. Other minor sterols were cholesterol, stigmasterol, Δ 5, 24-stigmastadienol, Δ 7-avenasterol, and Δ 7-stigmastenol, esterone, ergosterol, estrogen and brassicasterol (Mrabet et al., 2022).

Table 7: Date seeds oil composition of sterols (Mrabet et al., 2022).

Content (mg/100 g)	Composition
300-350	β -sitosterol (80%), campesterol (10%), Δ 5-avenasterol (4.5%), stigmasterol (2.42%), cholesterol (0.96%), Δ 5,24-stigmastadienol (0.41%)
470-845	Not detected
336	β -sitosterol (76%), campesterol (8.89%), Δ 5-avenasterol (8.79%), Δ 5,24-stigmastadienol (2.73%), Δ 7-avenasterol (1.18%), stigmasterol (1.09%), Δ 7-stigmastenol (0.79%), cholesterol (0.42%) avenasterol (1.18%), stigmasterol (1.09%), Δ 7-stigmastenol (0.79%), cholesterol (0.42%)

II.2. Phytochemical composition of date seeds

Phytochemicals are therapeutic in action when consumed as medicinal drugs or as components of daily diets. As observed in most fruits, bioactive compounds like carotenoids, polyphenols majorly phenolic acids and flavonoids, sterols and tannins are observed in varying quantities in dates and in date seeds. The proportion and concentration of these components enormously vary with respect to some parameters such as stage of fruit picking, date variety, postharvest processing, storage, soil conditions and geographical origin of the dates (Idowu et al., 2020).

Indeed, most of these compounds are endowed with beneficial properties to human health (e.g., in the prevention of cancer and cardiovascular diseases), that may be largely ascribed to their potent antioxidant and scavenging activity against reactive oxygen species generated in settings of oxidative stress and responsible for the onset of several pathologies (Panzella et al., 2020).

Generally, dates seeds are an excellent source of phytochemical compounds like phenolic acids, flavonoids, tannins, phytosterols and carotenoids. The presence of these compounds in varying proportions could promote their nutraceutical potentials (Idowu et al., 2020).

II.2.1. Polyphenols

Palm date pits as a source of bioactive chemicals have received only a limited attention. They include bioactive compounds such as polyphenols, which are important for human health (Swallah et al., 2020).

Phenolic compounds are phytochemicals that are broadly represented in plant kingdom, and their occurrence in easily accessible low-cost sources like wastes from agrifood processing has led in the last decade to an increase of interest in their recovery and further exploitation (Panzella et al., 2020).

Phenolic compounds mainly depend on plant food structure and the interaction with other food constituents, mostly proteins, lipids, and carbohydrates or can occur as derivatives, such as ester or methyl esters. The interaction with the food matrices can obstruct or enhance nutrient accessibility and availability and even impair others (Swallah et al., 2020).

Among the several classes of phenolic compounds, the phenolic acids, flavonoids, and tannins are regarded as the main dietary phenolic compounds. Many studies have shown a strong and positive correlation between the phenolic compound contents and the antioxidant potential of fruits and vegetables. Molecular structures, particularly the number and positions of the hydroxyl groups, and the nature of substitutions on the aromatic rings, confers to phenolic compounds the capacity of inactivating free radicals by donating hydrogen atoms, electrons, or chelating metal cations. Which is referred to as structure-activity relationship (SAR) (Minatel et al., 2017).

- **Polyphenols in date seeds**

As it has already been demonstrated in other fruits and corresponding seeds, total polyphenol content of the date seeds was higher than in the edible flesh (Idowu et al., 2020).

Soluble phenolic compounds such as flavonols, hydroxybenzoates and hydroxycinnamates have been described in date seeds. Dactyliferic acid with its isomers, alongside flavonoids glycosides (apigenin, luteolin and quercetin) were observed in Deglet Noor and other Algerian varieties. Parts of the identified phenolic compounds in dates are also malonyl derivatives, chrysoeriol, isorhamnetin, 3-methyl-isorhamnetin and kaempferol. The presence of these phenolic compounds affirmed the antioxidants potentials of dates (Idowu et al., 2020).

Moreover, according to literature data, date seeds contain more tannins than the fruit itself. It is observed that most phenolics in date seeds were present in tannin form for more than 50%. Seeds of date cultivars had great variations in their contents of tannins. Total tannin contents of seeds were in the range of 13-36.5 mg gallic acid/g DW (**Mrabet et al., 2022**). Date seeds also had about 3% DW of condensed tannins otherwise known as proanthocyanidins (**El-Mergawi et al., 2016**).

Phenolic compounds are also present in the unsaponifiable matter, or “minor constituents” of seeds date oils. On average, the total phenolic content of these oils ranged from 0.64 to 1.27 mg/g oil. Phenolic compounds play an important role in seed oils regarding flavor, shelf-life, and resistance to oxidation (**Khatri, 2015**).

However, the formulation, distribution and nature of phenolic compounds in dates rely on environmental conditions, growth stage, and variety and differed according to the cultivar (**Idowu et al., 2020**).

II.2.2. Carotenoids

Carotenoids are a class of more than 750 naturally occurring pigments synthesized by plants. These richly colored molecules are the sources of the yellow, orange and red colors of many plants (**Pauling, 2022**). They are tetraterpenoid compounds of significant dietary significance since they participate in defense of cells and the attractive optical color they provide makes them an attractive choice for the consumers (**Pradhan et al., 2022**).

- **Carotenoids in date seeds**

Carotenoids have been recorded as a key part of phytochemicals found in the lipid portions of date fruit. They are vitamin A precursors, which performs a key function in vision and shield the cells from deteriorating impacts of reactive radicals by acting as antioxidants. According to data, date seeds are made up of β -carotene and lutein as vital carotenoids (**Idowu et al., 2020**). Their content of carotenoids ranged from 2 to 5 mg/Kg (**Mrabet et al., 2022**).



Chapter III
Biological activities of date
palm seeds

Date palm fruits, seeds and byproducts can be regarded as a promising medicinal fruit owing to its therapeutic, nutritive and bioactivity potentials. It can act as a cheap source of natural diet majorly in the agrarian communities where diseases outbreak and malnutrition are common. Industrially, it can serve as an additive for development of health promoting products for the emerging food and pharmaceutical market.

III.1. Traditional therapeutic applications

Traditionally, dates are used as a prophylactic and therapeutic ingredient since ancient times in different nations like Morocco, Iraq, India, Algeria, Iran and Egypt. Demulcent, diuretic, expectorant, restorative and laxative properties have been linked to dates and their seed (**Idowu et al., 2020**).

Consumption of dates was recommended for people with jaundice ailment as well as for pregnant women. Its extensive application for traditional cure of liver and malaria infection in the Arab Peninsula has been denoted. In south-eastern Morocco, dates were used for the treatment of diabetes and hypertension according to historical facts. In another instance, kernels from dates were linked to reduction of skin wrinkling and anti-aging in women (**Idowu et al., 2020**).

According to former studies, dates have been suggested to help in hardening of infant gum for better dental development. They help strengthen gums and make teeth grow stronger and faster. In addition, dates can also assist to reduce dry cough, mild fever, headaches and lethargy when cooked with cardamom and black pepper (**Idowu et al., 2020**). In traditional medicine, the seed powder is used as an ingredient in a paste to relieve ague (fever) (**Khatri, 2015**).

It is widely known that there was less availability of scientific research to experimentally prove the medicinal effects of date palm in ancient time; however recent investigations are beginning to validate these claims to show their therapeutic mechanism (**Idowu et al., 2020**).

Therefore, several studies demonstrated that date pits have interesting health benefits and biological properties.

III.2. Health beneficial effects and biological activities

Date seeds are an excellent source of chemical compounds in varying proportions that could promote their nutraceutical potentials which include antimicrobial, antioxidant, anticancer and anti-inflammatory capacities (**Idowu et al., 2020**).

III.2.1. Antimicrobial activities

Antimicrobial property of a solid or liquid substance entails its potential to go inside cytoplasmic membrane, disrupt permeability and then destroy the cytoplasmic membrane, resulting to vulnerability of cytoplasm or cytoplasm coagulation and decrease in shape followed by cell lysis and then termination of microorganisms (**Idowu et al., 2020**).

The application of natural antimicrobial agents is preferred in tackling resistant bacteria and viruses because they are less expensive and have no side effects. Various experiments have been carried out to validate the antibacterial activities of different date seeds varieties. They possess antimicrobial property against some pathogenic bacterial strains such as *Serratia marcescens*, *Staphylococcus aureus*, *Bacillus cereus* and *Escherichia coli*. Date seed extracts indicated potent effect against lytic *Pseudomonas* phage ATCC 14209-B1, lowered the phage function and totally disrupted bacterial lysis. Besides, date extracts improved the antifungal potency of amphotericin B. Therefore, dates could be used as a natural antimicrobial agent in food products (**Idowu et al., 2020**). Date seed act as antiviral agent against various pathogenic human viruses. It can be useful in treatment and prevention of many types of viral infections (**Al-Farsi et al., 2011**).

III.2.2. Antioxidant activities

Antioxidants play a pivotal role in food systems, human body cells and tissues by protecting against oxidative damage of toxic molecules called free radicals. Those free radicals are closely related with some known diseases such as cancer, heart disease, Parkinson's and Alzheimer's disease. In a food system, reactive oxygen species and free radicals are responsible for lipid oxidation during processing and storage which form the toxic reaction products and undesirable off-flavor. To tackle this problem, chemical formulated antioxidants e.g.: propyl gallate (PG), butylated hydroxyl toluene (BHT), butylated hydroxyl anisole (BHA), and tertiary butyl hydro quinone (TBHQ) are applied as antioxidants against lipid peroxidation. However, chemical formulated antioxidant has been reported to induce

cancer. Thus, natural antioxidants from food source are mostly preferred (Al-Farsi et al., 2011).

One antioxidant of local potency is the date seeds which are rich in antioxidants and have antioxidants and free radical scavenging capabilities that help to protect the body against oxidative stress damage (Khatrri, 2015).

In a recent research, antioxidant potential of date seed protein hydrolysates could be used as a potential functional food ingredient for health promotion. Another research found that Iranian date seeds are strong radical scavengers and can be considered as a good source of natural antioxidants for medicinal and commercial uses (Al-Farsi et al., 2011). In China, dates was rated the second most potent in terms of antioxidant activity out of 28 different fruits that were extensively studied. Thus, antioxidant properties of dates can be used in foods as a replacement for the synthetic ones (Idowu et al., 2020).

Date seed oil has the potential to be used in cosmetic and pharmaceutical practices as well. Date seed oil can protect against UV-B and UV-A radiation due to its absorbance spectrum of UV radiation, which is responsible for most cellular damage to skin, so date seed oil may be used in the formulation of UV protectors. Date seed oil has been studied as a chemopreventive agent using a normal human epidermal keratinocyte model, concluding that this oil was able to prevent oxidative damage caused by H₂O₂ exposure through the lipid peroxidation process that is better than olive oil. Besides, it did not show any toxic effect on cells at a dose as high as 30 µg/mL (Mrabet et al., 2022).

The same authors irradiated human skin samples with UV-B and observed that skin cultures with date seed oil had four times lower DNA damage than those without it for the same irradiation level (Mrabet et al., 2022).

The defense against reactive oxygen species (ROS), which are responsible for cellular oxidative damage, is not limited to skin care (Mrabet et al., 2022).

In another study, the effects of date seed oil on human sperm motility and viability has been tested after in vitro H₂O₂-induced oxidative damage. It showed that date seed oil has a protective effect on both sperm parameters, especially after 24 h incubation (Mrabet et al., 2022).

III.2.3. Anti-inflammatory activities

Trauma in the human body can cause inflammation. Pro-inflammatory mediators serve to fight infectious microorganisms and repair damaged tissues. However, if inflammation lasts long due to low immunity, healing processes can be inhibited. Infection caused by microorganisms can be prevented by providing antioxidants as anti-inflammatory agents to boost the immune system (Saryono et al., 2018). Date seeds possess anti-inflammatory, immune-stimulatory and anti-atherogenic properties. However, not much is known about these activities (Saryono et al., 2018).

The efficacy of date syrup to tackle angiogenesis and inflammation has been reported. Rat studies suggested that the constituents of date extracts like steroids, fiber, minerals and polyphenols are likely to be pivotal for their anti-inflammatory activities (Saryono et al., 2018).

Decreases in pro-inflammatory mediators reduce inflammatory processes and mitigate pain and fever. Cyclooxygenase (COX) and pro-inflammatory mediators, including prostaglandin E2 (PGE-2), interleukin (IL)-1, and IL-12, are important inflammatory mediators. However, their excessive activity can disrupt the healing process. The findings obtained indicate that date seed extract act as anti-inflammatory agents via down regulation of COX-1, COX-2, PGE-2, IL-1 β and IL-12. The activity of the compounds in date seeds appears similar to that of dexamethasone. This finding should promote the development of date seed-based products as therapeutic agents for suppressing inflammations (Saryono et al., 2018).

III.2.4. Anticancer properties

Dates have been reported in experimental trials to be effective in lowering the growth of cancerous cells. They inhibit the proliferation of marginal cell in colon, breast, prostate, lung and gastric tumor lines. Also, eating of dates could enhance the colon in human body as a result of the increment in the growth of beneficial gut bacteria that result in reduction of tumor cell procreation. It is also demonstrated that date seeds contain β -glucan, of which its irradiated form, β -d-glucan was able to deactivate the proliferation of three cancer cell lines such as MCF7, Colo-205 and T47D (Idowu et al., 2020).

III.2.5. Anti-diabetic properties

Current medications used for management of diabetics are effective but possess some negative side effects such as disruption of genetic and metabolic pathway. Thus, extracts from natural plant that can elevate insulin generation and retard intestinal glucose intake are used presently in diabetes management (**Idowu et al., 2020**).

Date seeds are found useful in treating blood sugar related problems, diabetes and its related complications. According to a recent research date seeds have shown potential protective effects against early diabetic complications of both liver and kidney (**Al-Farsi et al., 2011**).

Meanwhile, dates and their seeds active compounds (flavonoids, phenols, steroids and saponins) can act as anti-diabetic ingredients that inhibit α -glucosidase, therefore controlling glucose intake in the kidneys and small intestines. In addition, it was shown that these compounds stabilize the proper functioning of the kidney and liver in several diabetic rat experiments. Thus, the anti-diabetic property of dates can be utilized for medical applications (**Idowu et al., 2020**).

Dates are known to act also as anti-hypertensive ingredient for centuries. They can lower hypercholesterolemia, oxidation of lipoproteins and hypertension, thus reducing series of reaction that could triggers cardio-vascular diseases initiation and progression. The other functions of date seeds are described below:

- **Prevent DNA damage**

According to a study, date seeds have shown defensive effect against chemically-induced liver damage and oxidative DNA damage. Date seeds provide protection against the liver intoxication, and this hepato-protective effect might be attributed to the antioxidant and free radical scavenging activities (**Khatri, 2015**).

- **Prevent kidney and liver damage**

Date seeds are rich in proanthocyanidins that actually helps to protect liver and kidney from damage. A study states that proanthocyanidins-rich date seed extract protects against chemically induced kidney and liver toxicity (**Khatri, 2015**).

- **Healing wounds**

One of the benefits of date seed is gash healing. Date seeds can treat ordinary or septic wounds. The injury will heal by burning the date seed and putting it in the sand place (**Khatri, 2015**).

- **Diarrhea treatment**

Date seeds are good for treating digestive disorders, especially chronic diarrhea. Organic dates also act as a powerful disinfectant and kill bacteria that enter the alimentary tract (**Khatri, 2015**).

- **Increase immunity for pregnant women**

Date seed increases milk of breastfeeding mothers and supports the immune system in pregnant women (**Khatri, 2015**).

III.2. Nutraceutical potentials

Due to their interesting nutritional properties (high content of dietary fiber and phenolics), date seeds represent a potential strong candidate as functional ingredient for human food. A recent study showed that date seeds exerted antioxidant activity in rats fed with diets containing 7% and 14% date seed powder for 30 days (**Idowu et al., 2020**).

Although some amount of caffeine is good for health it has many serious health risks such as high blood pressure, hypertension among young adults, gout flare up, insomnia, indigestion, infertility, inhibition of collagen production in skin etc. Caffeine is an addictive drug whose consumption must be limited (**Venkatachalam et al., 2016**).

Hence an alternate natural substance that has almost same tastes and smells like coffee and that has no health risk is very much needed. Roasted date palm seed is taken as a substitute or coffee that has no health risk and contains significant amounts of beneficial food ingredients such as oleic acid, dietary fibers and polyphenols. These compounds have been associated with reduced incidence of cardiovascular diseases and improved overall well-being (**Venkatachalam et al., 2016**).

Moreover, a coffee-like product is made from date seeds by drying, roasting, and grinding them in a similar way to coffee beans, to produce caffeine-free coffee (**Al-Farsi et al., 2011**).

Based on the fatty acid composition of date seed oil, it is suggested the use of this oil for nutritional purpose, as edible cooking oil, for frying, or seasoning oil, or even as an alternative to palm olein. It is also used for the production of margarine due to its high stability and resistance to thermal treatment which indicate the good shelf life and storability of this oil even for a long period of time (**Khatri, 2015**).

In addition, their content of carotenoids is adequate for margarine production since they provide a natural yellowish butter-like color without the addition of synthetic colorants. Otherwise, the conventional corn oil has been replaced with date seed oil for producing mayonnaise, which had higher sensory characteristics than the control. However, any applications for human consumption must be investigated for their complete safety (**Mrabet et al., 2022**).

III.3. Other uses

Date palm by-products can be widely used in local livestock feed, thus replacing other foods that are often unavailable in sufficient quantities and much more expensive (**Chehema et al., 2006**). So, date seeds are used as fodder for cattle, sheep, camels, and poultry and their utilization in animal feed will improve weight gain and feed efficiency (**Khatri, 2015**).

On other hand, the seeds oil is benefict to skin and is suitable for use in soap and cosmetic products. So, this oil has been used to replace the portions of other vegetable oils in body creams, shampoos, and shaving soap formulations, and, in general, the quality of these cosmetic formulations has been improved. They are also used to thicken and moisturize hair (**Khatri, 2015**).

The main health benefits of date seeds oil are abridged below:

Date oil helps to create an optimal environment for hair growth by removing dandruff and acne (**Khatri, 2015**).

Date oil has high amino acid and riboflavin (vitamin B2) content that can effectively curb hair loss. Amino acid is essential in producing keratin, the protein responsible for strengthening the follicles and increasing hair elasticity (**Khatri, 2015**).

Date seed oil rich in copper and pantothenic acid encourage our body to produce enough melanin (**Khatri, 2015**).

Date seed oil is efficient for repairing nails due to its variety of vitamins, especially vitamins K and A (**Khatri, 2015**).

This oil is also adequate for the production of biodiesel because of its low content of free fatty acids. Another industrial application that has been explored is as feedstock for the synthesis of poly (3-hydroxybutyrate) (PHB), biodegradable polyester that could replace contaminating plastics. The microorganism *Cupriavidus necator* can use date seed oil instead of edible vegetable oils as a sole carbon source and produce PHB at a reasonably good concentration and accumulation (**Mrabet et al., 2022**).

On the other hand, many works have aimed at the valorization of by-products of dates. By studying the effect of the incorporation of date kernels on the technological and functional characteristics of soft wheat flour, **Khali et al. (2014)** demonstrated that date kernels allowed interesting flour yields and the low humidity of these flours facilitates their preservation. Breads made by incorporation of this flour are all on the whole acceptable in terms of flavor and color. Moreover, margarine enriched with date kernel oil proved to be more resistant to oxidation than the control margarine (**Kaanin et al., 2012**).

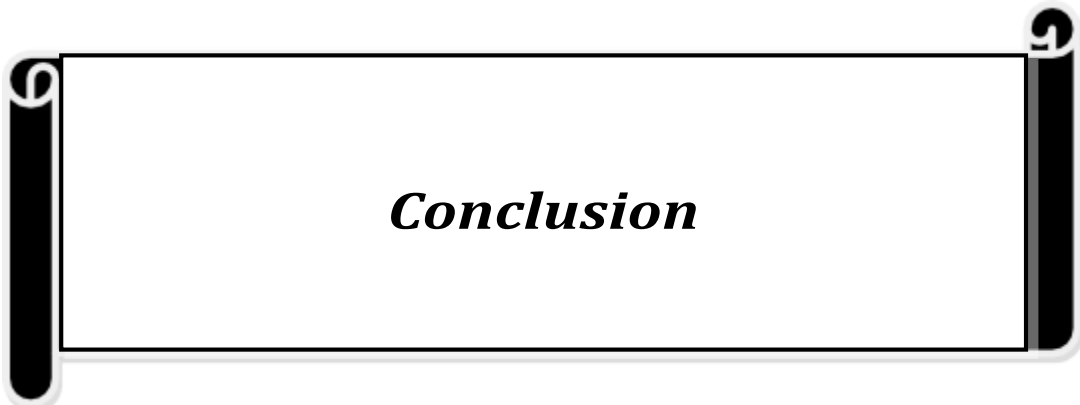
On the other hand, date scraps can be used as an extra supplement on the milk production of ewes. Their use during the last two months of gestation in insufficient grazing conditions is effective in improving the growth of lambs by increasing the milk production of their mothers (**Boudechiche et al., 2011**).

The preparation of vinegar from date waste could also be considered, in fact, the richness of the juice in sugar, offers the possibility of obtaining an alcoholic solution with an alcoholic degree of 8.5 ; which is a suitable amount of acidification with a yield of 80.7%. Moreover, the chemical, biological and organoleptic analyzes make it possible to affirm that the product produced (vinegar from date waste) meets the standards set by the CPIV (Comité International Permanent du Vinegar) and the Joint FAO/WHO Committee, 1979 and 1992 (**Boughnou, 1988**).

Waste of two varieties of dates (Deglet Nour and Hamraya) was used for the bioethanol production with fairly high efficiency, similar to industrial ethanol (**El-Hadj et al., 2016**). In Adrar region from Algeria, date waste was also transformed into bioethanol (**Boulal et al., 2010**).

Scrap dates was used to substitute cane molasses in order to produce baker's yeast (*Saccharomyces cerevisiae*) (Ould El Hadj et al., 2006). Acourene et al. (2008) valorized scrap dates by the production of baker's yeast, alcohol and vinegar.

In application in water treatment, Sekirifa et al. (2005) found that powdered activated carbon made from date pits as adsorbents could eliminate a large number of pollutants. The activated carbons used are capable of retaining organic matter (BOD, COD) and phenol in an aqueous medium. It showed a maximum adsorption capacity of 112.359 mg/g (for the adsorption of phenol in aqueous solution), and 51.546 mg/g (in the case of adsorption in terms of BOD). Similarly, Mahrez et al. (2016) found that biosorbent prepared from the cores of Algerian dates were efficient in the adsorption of methylene blue (MB) from aqueous solutions. In addition, the mixture of olive pomace and date pits can be considered as available and natural affective adsorbents for the removal of chromium in an aqueous solution (Aksas et al., 2016). Date stones were also employed for the elimination of Fe²⁺ ions in aqueous solution (Adrar, 2016).



Conclusion

Conclusion

Date palm is one of the most important fruit crops in many parts of the world that are usually characterized by arid, high-temperature climate. The fruits (dates) of the date palm were consumed as staple food and believed to have remarkable nutritional, health, and economic value. Their commodity trade has been steadily rising in recent years, reflecting greater demand from all five continents of the world. Date palm constitutes a major source of food and its by-products can be utilized in a range of items from construction to clothing. This makes date palm an ideal crop for low-income countries, where poverty and hunger prevail.

Date seed is one of the waste products, generated in a huge amount in the date's production process, which is generally used in animal feeding or used in making non-caffeinated coffee. It can also be used as a source of oil, as a raw material for activated carbon or as an adsorbent for dye-containing waters. Date pits are also listed in folk remedies for the management of diabetes, liver diseases and gastrointestinal disorders.

Recent studies indicate that date seeds contain significant and a wide range of beneficial food ingredients such as oleic acid, dietary fibers, and polyphenols. These compounds have been associated with reduced incidence of cardiovascular diseases, ameliorate gastric ulceration and improved overall well-being. Therefore, they represent a potential strong candidate as functional ingredient for human food

Date seeds have several amazing medicinal properties, they help to prevent kidney and liver against toxicity or damage, useful in diabetes, prevent DNA damage and help fighting various viral infections.

Date seeds have extractable high-value-added components. However, very little uses are known for this by-product. Thus, utilization of such waste is very important for date cultivation and to increase the income to this sector. Due to their interesting properties and compositions, date seed extracts represent a source of bioactive substances for human health.

Therefore, more studies are necessary to help us benefit each and every component of this rich byproduct which is going to allow us to consider industrial exploitation and technological development in the food, pharmaceutical and cosmetic industries.

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Abstract

The cultivation of the date palm (*Phoenix dactylifera* L.) is the main activity and source of livelihood for people from arid and semiarid regions of the world. Date production is increasing every year, and great amounts of date seeds are produced. These by-products, are wasted, causing environmental issues. However, this co-product is rich in various nutrients, and it can be used for many applications due to its valuable chemical composition. Date seed oil contains saturated and unsaturated fatty acids with lauric and oleic as the main ones, respectively. Tocopherols, tocotrienols, phytosterols, phenolic acids, tannins, flavonoids and carotenoids are also present. The presence of these compounds in varying proportions could promote their nutraceutical potentials. These nutraceutical potentials include antimicrobial activities, antioxidant capacities, anticancer.....etc. These phytochemicals confer added value to date seed, which could be used for many applications, such as food product formulations, cosmetics, and pharmaceuticals.

Keywords: Date seeds, biological activities, phytochemicals, date seed oil, chemical composition, nutrients.

Résumé

La culture du palmier dattier (*Phoenix dactylifera* L.) est la principale activité et source de revenus pour les populations des régions arides et semi-arides du monde. La production de dattes augmente chaque année et de grandes quantités de noyaux sont produites. Ces sous-produits sont gaspillés et causent des problèmes environnementaux. Toutefois, ce coproduit est riche en nutriments divers, et peut être utilisé pour de nombreuses applications en raison de sa composition chimique précieuse. L'huile des noyaux de dattes contient des acides gras saturés et insaturés dont les principaux sont laurique et oléique, respectivement. Les tocophérols, les tocotrienols, les phytostérols, les acides phénoliques, les tannins, les flavonoïdes et les caroténoïdes sont aussi présents. La présence de ces composés dans des proportions variables pourrait favoriser leurs potentiels nutraceutiques. Ces potentiels nutraceutiques comprennent des activités antimicrobiennes, des capacités anti oxydantes, anticancéreuses..... etc. Ces composés photochimiques confèrent une valeur ajoutée aux noyaux de dattes, qui pourrait être utilisé pour de nombreuses applications, telles que les formulations de produits alimentaires, cosmétiques et pharmaceutiques.

Mots clés : Noyaux de dattes, activités biologiques, photochimiques, huile des noyaux de dattes, composition chimique, nutriments.