

Biochemical and Nutritional Characterizations of Date Palm Fruits (*Phoenix dactylifera L.*)

El-Sohaimy S.A. and Hafez E.E.

Food Science and Technology Department, Mubarak City for Scientific Research and Technology Applications, Universities and Research Centers District, Borg El-Arab, 21934, Alexandria, Egypt.

Abstract: The date (*Phoenix dactylifera L.*), a high-energy fruit, is regarded as a popular food commodity for thousands of years in Egypt, the Arabian Gulf peninsula and its neighboring region. The aim of present study is to characterize the biochemical and nutritional values of constituents of the Egyptian date fruits. Date palm fruits contain a variety of B-complex vitamins B1, B2, Nicotinic acid and vitamin A. The date palm extracts contains 13.80 % moisture and 86.50 % total solid. Ash and Crude fibers contents were 2.13 and 5.20 respectively. Protein, carbohydrates and lipids contents were 3.00%, 73.00% and 2.90 % respectively. The low level of lipids content 2.90% compared with its content of sugars means that, the date palm is safe to heart and blood patients because its containing a very low level of fatty acids and cholesterol. HPLC analysis of sugars content showed that, the carbohydrate content consists of a large amount of glucose, fructose and sucrose. The protein pattern on SDS-PAGE showed that, most of proteins in the date palm are a high molecular weight proteins between 80 and 135 KD and contained a minimum levels of the LMW proteins less than 55 KD. Date Palm contained high concentration of Aspartic acid, Proline, Glycine, Histidine, Valine, Leucine and Arginine, but low concentration of Threonine, Serine, Methionine, Isoleucine, Tyrosine, Phenylalanine and Lysine and very low concentration of Alanine. The date palm fruits provide unique functional and nutritional values. Numerous health benefits beyond its nutritional value have been associated with consuming date palm fruits to enrich nutrition values of different kinds of food.

Key words:

INTRODUCTION

Dry or soft dates are eaten out-of-hand, or may be seeded and stuffed, or chopped and used in a great variety of ways: on cereal, in pudding, bread, cakes, cookies, ice cream, or candy bars. The pitting may be done in factories either by crushing and sieving the fruits or, with more sophistication, by piercing the seed out, leaving the fruit whole. The calyces may be mechanically removed also. Surplus dates are made into cubes, paste, spread, powder (date sugar), jam, jelly, juice, syrup, vinegar or alcohol. Discolored and filtered date juice yields a clear invert sugar solution. Libya is the leading producer of date syrup and alcohol^[23,42]. The fruit of the dates are good sources of sugars, of vitamin C, of provitamin A, of minerals and fibers. Its output in flesh added to its biochemical features, destined it to several potential technological transformations in the domain of food science, as: the moderate drying or the lyophilisation in view to produce an enriched flour, the extraction pulp in view

to produce mash or bracing refreshing drinks, the fermentation of the juice in view of the production of wine or vinegar, and finally the treatment of the pulp in order to produce jam and other candy products^[1,34]. The fruit yields food products such as date vinegar, date chutney or sweet pickle, date paste for bakery products and additional flavoring for oranges, bananas and almonds. The Arabian-flavored Bedouin dish known as Canua and roasted whole date seeds are popular as far away as Libya. Even the tree's terminal buds (heart of palm) make tasty additions to vegetable salads. The date palm is often the only available staple food for the inhabitants of desert and arid lands, and as such it is vital to millions throughout North Africa and the Middle East. According to the World Food and Agricultural Organization, there are 90 million date palms in the world and each tree can grow for more than 100 years. 64 million of these trees are grown in Arab countries, which produce 2 million tons of dates between them each year^[47,25,26,48]. The sugar content of ripe dates is about 80%; the remainder consists of

Corresponding Author: El-Sohaimy S.A., Food Science and Technology Department, Mubarak City for Scientific Research and Technology Applications, Universities and Research Centers District, Borg El-Arab, 21934, Alexandria, Egypt.
E-mail: elsohaimys@gmail.com

protein, fat and mineral products including copper, sulphur, iron, magnesium and fluoric acid. Dates are high in fiber and an excellent source of potassium. Five dates (approx. 45 grams) contain about 115 calories, nearly all from carbohydrates. Bedouin Arabs, who eat them on a regular basis, show an extremely low incidence rate of cancer and heart disease (19 and 21). Date Palm is a genus of palms, the most important species of which is the common date palm, the palm tree of Scripture, a native of the N. half of Africa, the S.W. of Asia, and some parts of India, and of which the cultivation is no less wide, and still extending. Some parts of China produce large crops. The stem, which is straight and simple, reaches a height of 30 to 60 feet, and bears a head of 40 to 80 glaucous pinnated leaves, 8 to 10 feet long, and a number of branching spadices, each of which on the female tree bears 180 to 200 fruits^[36]. A bunch of dates weighs 20 or 25 pounds, so that an average year's crop may be reckoned at 300 to 600 pounds per tree, and the yield per acre at about 12 times that of corn. This is one of the most important and useful of all the palms. In Egypt, and generally in North Africa, Persia, and Arabia, dates form the principal food and date palms the principal wealth of the people^[7,35]. Dates are cheap to produce and preserve, and are also very rich in nutrition. Dates contain a high percentage of carbohydrate, fat comprising 14 types of fatty acids, 15 salts and minerals, protein with 23 different amino acids and proteins^[5], six vitamins and a high percentage of dietary fiber. However, there are a number of inconsistencies in published data. For example, fiber content has been measured by a variety of methods including 'crude fiber', which does not give results that represent dietary fiber values. In other instances, the range or standard deviation of data has not been specified. The normal food we eat every day may not give us the required quantity of minerals and amino acids, for example, in comparison with what we might obtain from eating few dates. Increasing the production of dates has the potential to improve the nutrition of many people in areas where dates are eaten as a food rather than as a delicacy, as tends to be the case in the UK. In the Middle East, it is common to consume about 10-30 dates daily as part of the normal diet. In other countries where dates are grown, it is expected that similar amounts are eaten though there are no data that we are aware of. The consumption of 100 g dates daily (about six to seven dates) can provide between 50 and 100% of the recommended daily amount of fiber Walid Al- Shahib & Marshall,^[44] as well as other essential nutrients. Present production amounts to no more than 1 kg/person per year. The world production of dates has increased 1.5 times the increase in the world population in the past 40 years, showing that

there is potential for more use of dates as food^[43]. Date palm syrup provides unique functionality when used with milk in processing yogurt including sweetening, favoring and increasing nutritional quality. Numerous health benefits beyond its nutritional value have been associated with consuming yogurt enriched with 10 % date palm syrup^[10,28]. The tannin content of date palm fruits is used medicinally as a detergent and astringent in intestinal troubles. In the form of an infusion, decoction, syrup or paste, is administered as a treatment for sore throat, colds, bronchial catarrh. It is taken to relieve fever, cystitis, gonorrhoea, edema, liver and abdominal troubles. And it is said to counteract alcohol intoxication^[20,24,22,38,40]. The Dry date varieties ('El Tamr'), Matured fruits of this group contain a low moisture percentage 15 to 20% and high percentage of sugar 65 to 70% in which sucrose represents a significant part. They can be kept for a very long time under normal ambient temperature. The most important varieties in such group are: 'El Barakawi', 'El Abrimi', 'El Sakouti', 'El Barmatoda', 'El Malkabi', 'El Gondaila', 'El Gargoda', 'El Digna' and 'El Shamia'. These varieties are located in Aswan and Qena Governorates where the heat requirements needed for these varieties are available and range between 3,600 and 4,300 "F units during the growth season^[33,37]. The aim of present study is to characterize the biochemical and nutritional values of constituents of the Egyptian date fruits.

MATERIALS AND METHODS

Samples: All date fruits samples (*Phoenix dactylifera* L) were collected from Agricultural Research Center, Giza, Egypt.

Moisture Content: These methods rely on measuring the mass of water in a known mass of sample. The moisture content is determined by measuring the mass of a food before and after the water is removed by evaporation according to AOAC^[2,41].

$$\% \text{Moisture} = \frac{M_{\text{INITIAL}} - M_{\text{DRIED}}}{M_{\text{INITIAL}}} \times 100$$

Here, M_{INITIAL} and M_{DRIED} are the mass of the sample before and after drying, respectively.

The total solids content is a measure of the amount of material remaining after all the water has been evaporated:

$$\% \text{Total Solids} = \frac{M_{\text{DRIED}}}{M_{\text{INITIAL}}} \times 100$$

Thus, %Total solids = (100 - %Moisture). To obtain an accurate measurement of the moisture content or total solids of a food using evaporation methods it is necessary to remove all of the water molecules that were originally present in the food, without changing the mass of the food matrix. This is often extremely difficult to achieve in practice because the high temperatures or long times required to remove all of the water molecules would lead to changes in the mass of the food matrix, *e.g.*, due to volatilization or chemical changes of some components. For this reason, the drying conditions used in evaporation methods are usually standardized in terms of temperature and time so as to obtain results that are as accurate and reproducible as possible given the practical constraints. Using a standard method of sample preparation and analysis helps to minimize sample-to-sample variations within and between laboratories^[2,31].

Total fibers contents were determined by the method of Weende (cited by Wolff,^[12,46] Ash content was determined according to Gan *et al* and fennema^[8]. A rapid determination of vitamin A was carried out using HPLC according Hiroyuki Moriyama *et al*^[15]. Vitamin C was extracted according to Harris and Ray technique and measured according to Evered^[6], and Harris and Ray^[13]. Vitamin B1, B2 and Nicotinic acid were determined by RP-HPLC according Radaamidzic *et al*^[32]. Mineral contents of date fruits was measured according Musa Özcan^[27].

Lipid Extraction: Homogenised tissue (10 g) was progressively added to small amounts of a chloroform/methanol 2:1 (v/v) mixture (up to 200 ml), with vigorous shaking, and then the extraction was carried on for a further 2 h, using an electromagnetic stirrer. The mixture was filtered and the filter was re-washed with fresh solvent and pressed. Fifty millilitres of 0.88% potassium chloride were added and the mixture was shaken. The aqueous layer (upper) was removed by aspiration and the washing procedure was repeated. The extract was then dried by adding anhydrous sodium sulphate, which was filtered again, before the solvent was removed using a rotary evaporator. The extract was then placed in a desiccator overnight and weighed, according Folch *et al*^[9,45].

Total Carbohydrate: Chemical analysis for the determination of total carbohydrate was adapted from the phenol-sulphuric acid method as described by Dubios *et al*^[4]. Sample (1 mL) was mixed with 1 mL phenol solution (5% w/v) followed by addition of 5 mL concentrated sulphuric acid. The sample was left at room temperature for 30 min prior to measuring absorbance at 485 nm using a spectrophotometer (Ultrospec 2000, Amersham Pharmacia Biotech,

Piscataway, NJ, USA). The total amount of carbohydrate was determined based on a standard calibration curve prepared using glucose or dextran (average molecular weight: 2×10^6 Da, Sigma-Aldrich). All analyses using the phenol-sulphuric acid method were performed in duplicate^[4].

HPLC Analysis: Dried samples were ground through a 40-mesh screen (Wiley Jr. Mills, Arthur Thomas Co. Scientific Apparatus, Philadelphia, PA) and analyzed for moisture content (AACC 1983). Aliquots (5-10 g) were boiled for 20 min in 100 ml of 60% ethanol, cooled, and filtered through Whatman 42 paper. Additional sample cleanup was performed on the eluate by sequentially filtering through a Sep-Pak Plus C18 cartridge (Waters, Milford, MA) and a 0.22- μ m membrane filter before injection onto the HPLC (modified Picha 1985). At least duplicate samples were extracted for each product and processing stage, and duplicate analysis was performed on the individual extractions. The system (Waters) consisted of: model 600 pump, model 600E controller, WISP 700 automatic sample injector, and associated IBM-compatible computer. An Alltec refractive index detector (Knauer, Berlin, Germany) was used. The aminopropyl-bonded phase column (4gm high-performance carbohydrate column, Waters) was operated at 300 C. The mobile phase was an isocratic acetonitrile and water solution (75:25). Sodium chloride was added (0.125%, w/v) to minimize the interference from NaCl. Sugar standards were dried at 600C in a vacuum oven overnight and dissolved in 60% ethanol (modified Zygmunt 1982). Diverse samples were also spiked with various combinations of standard sugars (1 -5 ppm) to monitor recovery. Sugar concentration was calculated based on peak area measurements^[18].

Total Protein Analysis: The determination of total nitrogen (N) by Kjeldahl carried out as described by AOAC Helrich^[14] involves the transformation of organic N to ammonium (NH₄⁺) by digesting the sample with concentrated sulfuric acid (H₂SO₄) and then measuring the amount of NH₄⁺ produced. Potassium sulfate (K₂SO₄) or sodium sulfate (Na₂SO₄) salts are commonly used to increase the boiling point, and thus speed up the conversion reaction. The rate of organic matter oxidation is also increased under most conditions by the addition of copper (Cu), selenium (Se), or mercury (Hg) which serves as catalysts. If Hg is the catalyst selected, then sodium sulfide (Na₂S), sodium thiosulfate (Na₂S₂O₃ @ 5H₂O), or zinc (Zn) dust must be added to the digest to decompose the Hg-NH₄⁺ complex. The NH₄⁺-N created during the digestion procedure is determined by making the digest

strongly alkaline, commonly with sodium hydroxide (NaOH), and collecting the volatilized ammonia (NH₃) into a boric acid indicator solution by steam distillation^[3,16,29,30,39].

Amino Acid Analysis: Amino acid analysis carried out as described by Laury Sreinke, using vapor HCl hydrolysis of samples and standards at 110 degrees C for 19-20 hours. After hydrolysis, samples submitted on PVDF are extracted three times with 100 microliters of 40% acetonitrile/0.5% trifluoroacetic acid and the extracts dried completely in a Speed vac before resuspension in sample buffer. Samples and standards are then analyzed using a Beckman 6300 system^[17].

Lipid Extraction: The total Lipid extracted from the samples according Folch method^[9] by Chloroform: methanol 2:1 and shaking for 2 hr. then filtered and repeat for 5 times.

RESULTS AND DISCUSSION

In the pre-analysis of date palm the results showed that, the date palm extract contains 13.80 % moisture and 86.50 % total solid. Ash and Crud fibers contents were 2.13 and 5.20 respectively. Protein carbohydrates and lipids contents were 3.00%, 73.00% and 2.90 % respectively. These data revealed that, the date palm containing the most of essential nutritional matters which are necessary to human activities and saving their life. The low level of lipids content 2.90% compared with its content of sugars means that, the date palm is save to heart and blood patients because its containing a very low level of fatty acids and cholesterol.

Table 1: Total chemical analysis of date palm extract

Moisture %	13.80
protein %	3.00
Carbohydrates %	73.00
Lipids %	2.90
Crude fiber	5.20
Total calories / 100 gm	284 Cal
Total Solid%	86.50
Ash%	2.13

Table 2: The elements content

parameter	mg/100g	parameter	mg/100g
Ca	65	P	72
K	521	Fe	2.69
Mg	20	Se	0.34

Table 3: Vitamins content

Parameters	mg/100g
Vitamin A	0.04
Vitamin B1	0.08
Vitamin B2	0.05
Nicotinic acid	2.20

The element analysis of date palm extract showed that, the fruit of date palm contains many of valuable and useful elements like Calcium, Potassium, Magnesium, Phosphorous, Iron, and selenium in percentages of 65%, 521%, 20%, 72%, 2.69%, and 0.34% respectively as shown in table (2). These analyses accepted with many of previous literatures which revealed that the date palm contains a suitable concentration of calcium, potassium, phosphorus and selenium which are very important for human body and metabolic operations in the human cells.

Vitamins Content: The date palm fruit contains many kinds of vitamins like, Vitamin A, vitamin B1, B2 and Nicotinic acid with concentrations, 0.04, 0.08, 0.05 and 2.20 mg/100g respectively (table 3). It is revealed that, dates may be considered as an almost ideal food, providing a wide range of essential nutrients and potential health benefits.

Sugar Content: The general analysis showed that, the date palm extract contains a high level of carbohydrate content 73%. in the same time, the HPLC analysis of sugars content showed that, the carbohydrate content consists of a large amount of glucose, fructose and sucrose, which easy to digest in human cells and useful for getting the energy for metabolic processes, on the other hand containing a minimum quantity of Xylose mannose, lactose and lactulose as shown in Figer (1). Total calories / 100 gm equal 284 cal. nearly all from carbohydrates. Bedouin Arabs, who eat them on a regular basis, show an extremely low incidence rate of cancer and heart disease.

Protein Profile and Amino Acids Composition: SDS-PAGE of date palm extract showed that, the date palm protein profile showed a different types of proteins with a different MW, as shown if the Fig (2). The protein pattern on the gel showed that, most of proteins in the date palm are a high molecular weight between 80 and 135 KD and contained a minimum levels of the LMW proteins less than 55 KD. Also these results added value in the date fruits research area about their protein pattern.

The analysis of amino acids composition by HPLC showed that, the date palm extract contains, a high concentration of Aspartic acid, Proline, Glycine, Histidine, Valine, Leucine and Arginine, but low concentration of Threonine, Serine, Methionine, Isoleucine, Tyrosine, Phenylalanine and Lysine and very low concentration of Alanine (1.942 µg/ml) (Table 1). The data revealed that, the date palm extract contains suitable amounts of essential amino acids due to rising of its nutrition value.

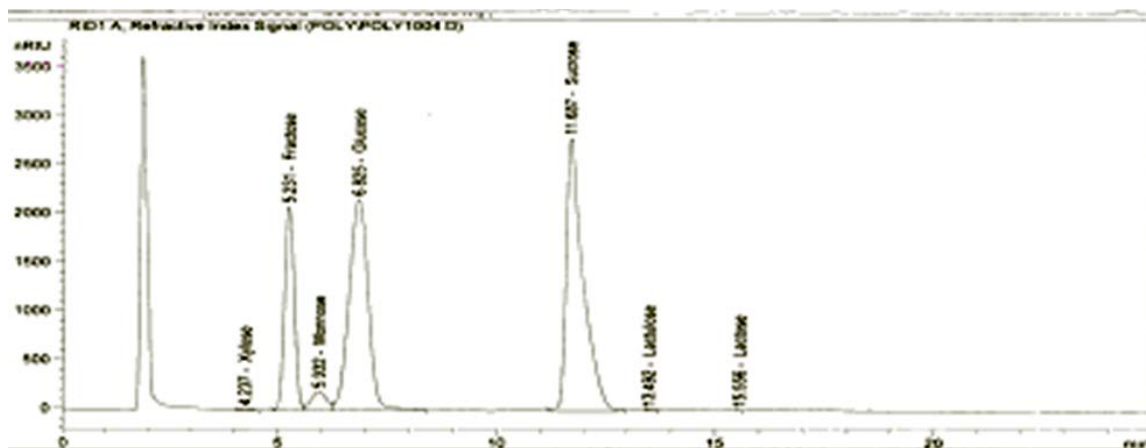


Fig. 1: HPLC chart of sugar analysis of date palm extract

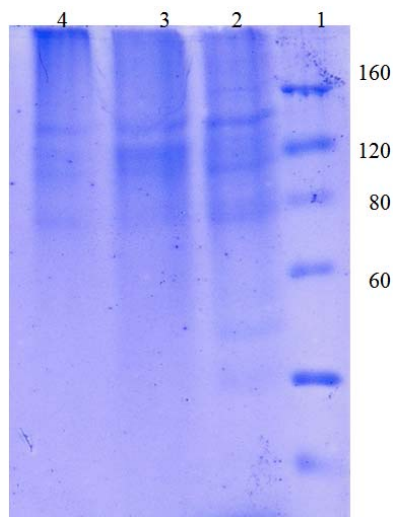


Fig. 2: SDS-PAGE of date extract Lan1: protein standard, lane2, 3, and 4: date palm samples.

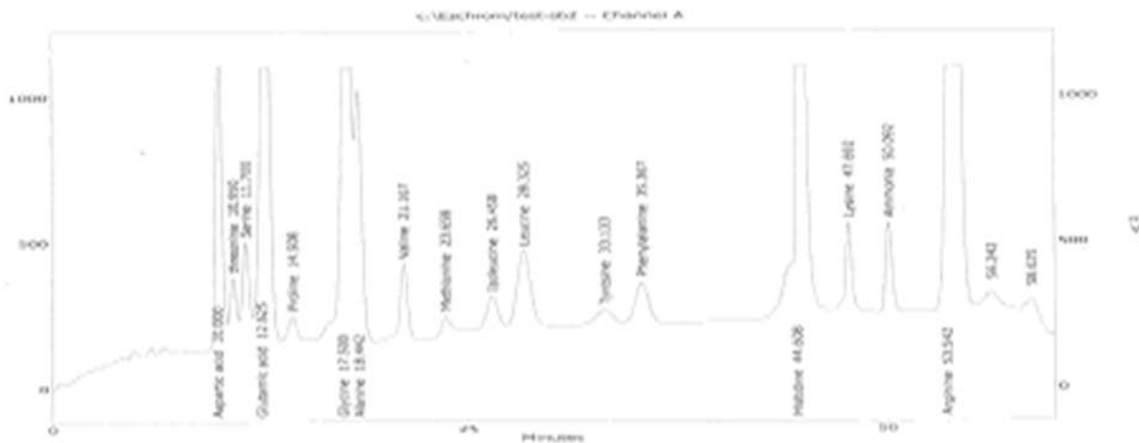


Fig. 3: Amino acid analysis chart of date palm extract

Table 4: Amino Acid contents of date extract

Amino acid	Conc. (u g/ml)	Amino acid	Conc. (u g/ml)
Aspartic acid	106.247	Isoleucine	41.333
Threonine	21.364	Leucine	57.894
Serine	27.786	Tyrosine	17.010
Glutamic acid	147.538	Phenylalanine	30.095
Proline	491.798	Histidine	210.789
Glycine	103.286	Lysine	33.689
Alanine	1.942	Ammonia	14.532
Valine	66.425	Arginine	364.478
Methionine	12.082		

Conclusion: Date palm fruits contains a variety of B-complex vitamins B1, B2, Nicotinic acid and vitamin A, these vitamins have a variety of functions that help maintain a healthy body – to metabolize carbohydrates and maintain blood glucose levels, fatty acids for energy, and they help make hemoglobin, the red and white blood cells. Magnesium and calcium are essential for healthy bone development and for energy metabolism. Iron is essential to red blood cell production. Red blood cells carry all the nutrients to cells throughout the body. Dates are fat and cholesterol free and contain an ideal amount of sodium when a recommended amount of sodium is no more than 2,400 to 2,000 milligrams per day. Consuming too much sodium may increase the risk of heart disease and hypertension. Today's healthy diets recommend eating foods that are low in sodium, fat, cholesterol and high in fiber. Dates fit perfectly into a healthy lifestyle. Dates are easy to digest due to its containing a high content of fiber. Hence it is help to regulate bowel movements and aid constipation. It can be used as natural laxatives for those suffering from constipation. The date fruits great as an energy snack as they contain natural sugars like glucose, fructose and sucrose that help to provide the body with instant energy. Dates are also a great source of potassium, a nutrient that is great in the maintenance of a healthy nervous system and in balancing the body's nervous system. Phosphorus works with calcium to help with bone strength and growth, potassium that helps to keep your muscles working correctly and selenium is important for cell growth and repair. The date palm fruits provide unique functional and nutritional values. Numerous health benefits beyond its nutritional value have been associated with consuming date palm fruits to enriched nutrition values of different kinds of food. Dates could have an important all-round role to play in dietary health. There is every possibility that they contain other components that may have useful functional properties.

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