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The fruit of the date palm: its possible use as the best food for the future?

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The fruits (dates) of the date palm (*Phoenix dactylifera L.*) 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%). 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. In many varieties, potassium can be found at a concentration as high as 0.9% in the flesh while it is as high as 0.5% in some seeds. Other minerals and salts that are found in various proportions include boron, calcium, cobalt, copper, fluorine, iron, magnesium, manganese, 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_1 thiamine, B_2 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. 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 by 1.71% over 40 years. In many ways, dates may be considered as an almost ideal food, providing a wide range of essential nutrients and potential health benefits.

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Introduction

The purpose of this review is to bring together some of the data on the nutritional characteristics of the fruits of the date palm that may not be generally available and to consider the potential for greater use of the fruits. Throughout this review, we will use the words 'date' or 'dates' to refer to the fleshy part of the fruit that can be eaten.

The date palm (*Phoenix dactylifera* L.) is one of mankind's oldest cultivated plants. It has been used as food for 6000 years (Amer, 1994). It could be used for generations to come due to its remarkable nutritional, health and economic value in addition to its aesthetic and environmental benefits. Every part of the date palm is useful. Dates offer useful prospects for fighting hunger and diseases. The importance of the date in human nutrition comes from its rich composition of carbohydrates, salts and minerals, dietary fibre, vitamins, fatty acids, amino acids and protein.

The date palm

Date trees can be 15–25 m tall and 20–40 cm in cross-sectional radius. The trunk is made of strong cellulose fibres and can be used in making plywood. There are more than 100 million date palm trees in the world. The yield of dates depends on many conditions. Some types of date palm can give 400–600 kg fresh crop per year (100–150 kg dry crop) for up to 60 years (Amer, 1994).

There are more than 2000 different varieties of fresh dates (Amer, 1994). Many fresh varieties are available throughout 8 months of the year. Packed, dry dates keep well without the addition of preservatives for at least 8 months, the high sugar content acting as an effective preservative.

Stages in the development of the fruit

The development of the fruit is classified into four stages using Arabic terms (Fayadh & Al-Showiman, 1990). Before Stage 1 and in the first 4–5 weeks of its life, the date is called 'altalaa', in which the date becomes green.

Stage 1: 'Kimri' stage
Characterised by two phases. In phase one, the date shows the following features:

- rapid increase in size and weight;
- increasing rate of accumulating of sugars;
- high acidity; and
- high moisture content.

In phase two: the date is characterised by:

- continued but reduced rate of increasing size and weight;
- reduced rate of accumulating of sugars;
- slightly reduced acidity; and
- higher moisture content than in phase one.

In the Kimri stage, the average fruit length is 27.5 mm and its diameter is 17.8 mm (Table 1). The average weight of five varieties of dates is 5.8 g. Dates in this stage contain an average of 5.6% protein, 0.5% fat and 3.7% ash (Al-Hooti *et al*., 1995).

Stage 2: 'Khalal' stage
The colour of the date changes from green to somewhere between yellow and red depending on the cultivar (3–5 weeks). The rate of change of the four features seen in phase two of the Kimri stage continues to decrease.

In this stage, the average fruit length increases to 32.5 mm and its diameter increases to 21 mm (Table 1). The percentages of protein, fat and ash decrease to 2.7%, 0.3% and 2.8%, respectively. The average weight of fruit increases to 8.7% (Al-Hooti *et al*., 1995).

Stage 3: 'Rutab' stage
The date begins to soften and lose water (2–4 weeks).

The protein, fat and ash percentages in this stage decrease to 2.6%, 0.3% and 2.6%, respectively.

Table 1. Characteristics of five varieties of dates in different stages of ripening

	Shahla	*Gash Gaafar*	*Gash Habash*	*Lulu*	*Bushibal*	*Mean, five varieties*
Kimri stage						
Fruit length (mm)	24.1	34.3	24.2	26	29.1	27.5
Diameter (mm)	18.8	12.7	18.1	23.2	16.1	17.8
Fruit weight (g)	4.6	7.6	4.6	7.5	4.6	5.8
Protein (%w/w)	5.6	5.5	5.8	5.7	5.6	5.6
pH	5.6	5.5	5.5	5.5	5.4	5.5
Ash (%w/w)	4.2	3.4	4.3	2.6	3.8	3.7
Fat (%w/w)	0.5	0.4	0.6	0.5	0.4	0.5
Khalal stage						
Fruit length (mm)	32	38.8	31	26.5	34.4	32.5
Diameter (mm)	23.1	20.8	20.5	23.5	17.2	21
Fruit weight (g)	9.7	10.6	7.6	9.2	6.5	8.7
Protein (%w/w)	2.3	2.6	3	3	2.7	2.7
pH	6.1	5.2	5.5	5.4	5.1	5.5
Ash (%w/w)	2.9	2.3	3.8	2.2	2.6	2.8
Fat (%w/w)	0.2	0.3	0.4	0.3	0.4	0.3

Stage 4: 'Tamr' stage

The date has now dried to a fairly firm consistency with darker colour but there are types of dates that do not develop to this stage.

Table 2 shows the average percentages of protein, fat and ash of 18 cultivars in the Tamr stage, as 2.3%, 0.2% and 1.7%, respectively.

Table 2. Composition of dates in the Tamr stage of ripening

Variety	*Protein (%w/w)*	*Ash (%w/w)*	*Fat (%w/w)*
Barhi	2.3	1.5	0.1
*Buchibal**	2.2	1.5	0.2
*Bushibal***	2.3	1.7	0.1
Fard	2.1	1.8	0.1
Gash Gaafar	2.4	2	0.1
Gash Habash	2.1	2.4	0.4
Gush Rabei	2	1.6	0.2
Hallawi	2.3	1.9	0.5
Hilali Ahmr	2.2	1.6	0.1
Khadrawi	2.4	2.1	0.5
Khulas	2.1	1.4	0.1
Khunaizy	3	1.4	0.1
*Lulu**	2.5	1.8	0.1
*Lulu***	2.4	0.3	0.2
Naghal	2.7	1.9	0.2
Naghal Hilali	1.9	1.3	0.1
Sayer	2.8	1.8	0.3
Shahla	1.7	1.9	0.2
Zahdi	2.2	1.9	0.4
Mean	2.3	1.7	0.2

*Ahmed & Ahmed (1995). **Al-Hooti *et al*. (1995). Others: Yousif *et al*. (1982).

Water content of dates

The moisture content of dates decreases as they ripen. In the Kimri stage it averages 83.6%, in the Khalal stage it is about 65.9%, and it continues to decrease through the Rutab stage (43%) to the Tamr stage (24.2%) (Table 3) (Ahmed & Ahmed, 1995). We have found that the moisture content of 13 varieties of dried date in this stage averages 12.7% (Al-Shahib & Marshall, 2002).

Carbohydrate content

Dates contain a high concentration of sugar, which is considered the main component. This carbohydrate is mainly reducing sugars in the form of glucose, fructose, mannose and maltose and non-reducing sugars (primarily sucrose), as well as small amounts of polysaccharides (such as cellulose and starch) (Shinwari, 1993).

The total concentration of carbohydrate in dates increases from the Kimri stage through the Khalal and Rutab stages, to the Tamr stage and depends on the type of date. The concentration of total sugars in the Kimri stages varies from 3.4 to 7.7% and the

Table 3. The moisture content of different varieties of date at different stages of ripening

	Moisture content (g/100 g)			
Variety	*Kimri stage*	*Khalal stage*	*Rutab stage*	*Tamr stage*
Barhi	83.2	62.6	39.7	29.5
Buchibal	83.7	76.5	35.9	18.0
Fard	82.7	72.1	37.6	27.7
Gush Rabei	85.1	64.1	44.7	25.5
Hilali Ahmr	84.6	74.0	45.8	31.1
Hilali Pakistan	84.2	70.5	44.2	–
Khasab	84.6	72.6	50.4	–
Khulas	83.7	58.9	41.3	22.3
Khunaizy	84.2	66.5	37.9	25.1
Lulu	81.7	62.2	45.2	21.3
Naghal	80.1	54.5	44.1	9.2
Naghal Hilali	85.5	57.0	48.9	32.1
Mean	83.6	65.9	43.0	24.2

concentration of total sugars in the Khalal stage varies from 18.8 to 31.9% (Ahmed & Ahmed, 1995). The concentration of total sugars in the Rutab stage varies from 43.9 to 50.1% while the concentration of total sugars in Tamr stage varies from 44.3 to 64.1% (Ahmed & Ahmed, 1995). In other varieties of date, the concentration of total sugars is as high as 88% (Shinwari, 1993).

The percentage of glucose and fructose in the flesh of *Barhi* dates increases from the Kimri stage (4.9% and 2.8%, respectively) to the Khalal stage (13.1% and 11.8%, respectively) through the Rutab stage (21.4% and 19.4%, respectively) to the Tamr stage (29.7% and 27.6%, respectively) (Table 4). The percentage of glucose and fructose in date seeds equals 10.8% and 7.3%, respectively, which is less than the percentage from the Khalal stage to the Tamr stage. Only sucrose exists in the Khalal stage at a concentration of 6.2%, whereas its concentration in the seeds is 51.4% (Ahmed & Ahmed, 1995; Al-Showiman, 1990). Mannose and maltose are only present in the seeds (Al-Showiman, 1990). The total concentration of sugars in the flesh of *Barhi* date is 57.3% and the relative percentage of sugar present in the alcohol extract of seeds is 86% (Al-Showiman, 1990). Similar results are found with other types of date (Ahmed & Ahmed, 1995).

The increase of the concentration of sugars from stage 1 to stage 4 is related to the decrease in the water content of date during these stages.

Fatty acid content

The flesh of dates contains 0.2–0.5% saponifiable oil, whereas the seeds contain 7.7–9.7% oil (Al-Hooti *et al*., 1998). The seed is 4.6–15.2% of the weight of the date (Mossa *et al*., 1986; Al-Showiman, 1990).

The fatty acids in flesh and seed occur as a range of saturated and unsaturated acids. The saturated fatty acids include capric, lauric, myristic, palmitic, stearic, margaric, arachidic, heneicosanoic, behenic and tricosanoic acids. Unsaturated fatty acids include palmitoleic, oleic, linoleic and linolenic acids. However, data published so far do not distinguish between α-linolenic and γ-linolenic contents.

In our recent results using seeds from 14 cultivars (Al-Shahib & Marshall, 2003), we found that the percentage of fatty acids varied from one seed to another. Table 5 shows that the seeds of dates contain 14 types of fatty acids. Only eight of these fatty acids exist in very low concentration in the flesh (Table 6). In more than 20 varieties of seeds, the concentration of oleic acid varies from 41.1 to 58.8% (Table 5), which suggests that the seeds of dates could be used as a source of oleic acid provided that technical problems in breaking open the seeds can be overcome.

Table 4. Total sugar of different varieties of dates at different stages of ripening (Ahmed & Ahmed, 1995

	Total sugars (g/100 g)			
Variety	*Kimri stage*	*Khalal stage*	*Rutab stage*	*Tamr stage*
Barhi	7.7	31.1	40.8	57.2
Buchibal	5.1	18.8	49.0	55.1
Fard	5.6	27.1	50.1	59.5
Gush Rabei	5.3	24.9	48.1	49.9
Hilali Ahmr	3.4	23.0	43.6	64.1
Hilali Pakistan	6.6	23.8	44.1	51.4
Khasab	7.6	22.9	41.7	60.6
Khulas	7.0	31.9	46.1	57.0
Khunaizy	6.4	23.4	46.2	53.9
Lulu	7.6	29.7	43.9	57.7
Naghal	5.1	30.6	44.2	44.3
Naghal Hilali	7.0	31.8	44.8	52.7
Mean	6.2	26.6	45.2	50.8

Mineral content

There are at least 15 minerals in dates (Table 7). The percentage of each mineral in dried dates varies from 0.1 to 916 mg/100 g date depending on the type of mineral. Dates contain elemental fluorine that is useful in protecting teeth against decay and selenium, which has roles in cancer prevention and maintenance of immune status (Al-Showiman, 1998). Dates are a very good source of many minerals with concentrations near to the average nutrient intake of minerals. Potassium can be found in many types of dates with the concentrations as high as 0.9%, and in some seeds it can be as high as 0.5% (Table 7). Other minerals and salts are found in various proportions: boron, calcium, cobalt, copper, fluorine, iron, magnesium, manganese, potassium, phosphorous, sodium and zinc.

Al-Hooti *et al*. (1995) pointed out that the mineral content of five varieties of dates depends on the ripening stage. The percentage of iron in four cultivars decreases from stage 1 to stage 4, whereas it increases in *Lulu* date. The percentages of calcium, magnesium, phosphorus, potassium, sodium and zinc in all five cultivars decrease from stage 1 to stage 4.

From ripening stage 1 to stage 4, The percentage of copper in two cultivars called *Shahla* and *Gash Habash* decreases, in *Gash Gaafar* and *Bushibal* cultivars it does not change, and it increases in the *Lulu* cultivar (Table 8).

In addition, other minerals and salts that are found in various proportions of seeds include aluminum, cadmium, chloride, lead and sulphur (Table 7).

The percentages of potassium, phosphorous and iron in dates are much higher than in other types of fruit. The amount of these three minerals in dates is three to five times the amount in grapes, apples, oranges and bananas (Al-Showiman, 1998). They also contain the mineral boron that is useful in the treatment of cancer of brain. Boron and vitamins are also used in the treatment of rheumatism (Al-Showiman, 1998).

The date is considered as a practical supplement for iron rather than iron tablets for those who have iron deficiency because it does not show side effects such as nausea, headache and anorexia (Anonymous, 1987).

Protein and amino acid content

Dates contain a higher percentage of protein than other type of fruits. They contain 2.3–5.6% protein, whereas apples, oranges, bananas, and grapes contain 0.3%, 0.7%, 1.0% and 1.0%, respectively (Al-Showiman, 1998).

Twenty-three different amino acids have been found in the proteins of dates. Many of these are not present in the most popular fruits such as oranges, apples and bananas.

Table 5. Fatty acid content of date seeds (g/100 g fat)

	Saturated fatty acid									*Unsaturated fatty acid*					
Cultivar	*C8:0*	*C10:0*	*C12:0*	*C14:0*	*C16:0*	*C17:0*	*C18:0*	*C20:0*	*C21:0*	*C22:0*	*C23:0*	*C16:1*	*C18:1(9)*	*C18:2(9,12)*	*C18:3***
Al-Showiman (1990)															
Barhey		0.5	24.7	11.8	8.6	0.1	0.3	0.5	0.1	0.5	0.1	0.1	48.5	3.3	0.4
Maktomey		0.4	20.6	10.0	7.9	0.1	0.2	0.5	0.1	0.2	0.1	0.1	56.9	1.9	0.3
Sekkeri		0.5	23.8	11.4	9.6	0.5	0.3	1.3	0.5	0.8		0.5	42.6	3.4	1.3
Fankha		0.4	20.6	11.4	10.1	0.4	0.2	0.7	0.6	2.2	0.1		50.2	0.2	0.7
Khasba		0.3	15.4	7.4	6.7		1.3	0.5	0.1	0.3		0.1	55.9	2.8	0.4
Al-Hooti *et al*. (1998)															
Bushibal			6.7	5.3	10.6		2.0	0.8	0.7				58.8	12.8	0.2
Gash Gaafar		7.1	5.2	13.8		1.4	0.7	0.5				57.1	11.9	0.2	
Gash Habash		6.3	5.5	11.1		3.7	0.7	0.6				58.3	11.6	0.1	
Lulu			10.6	7.0	12.0		3.0	0.5	0.6				53.2	10.7	0.1
Shahla			10.9	7.0	11.9		2.9	0.5	0.6				53.2	10.7	0.1
Al-Shahib & Marshall (2003)															
Suqaey	0.1	0.5	13.1	11.6	11.4		3.3						50.3	9.0	
Sukkary	0.1	0.3	8.4	10.4			4.8								
Safawy	0.3	0.3	11.2	10.6	12.3		4.1						50.5	9.0	
Sofry	0.3	0.5	14.0	12.1	12.4		4.3						45.5	9.6	
Anbarah	0.4	0.3	15.6	12.7	11.6		4.3						44.9	8.9	
Rebeaah	0.0	0.0	24.1	14.5			2.7						40.6	6.0	
Shalaby	0.0*	0.4	13.7	14.0	13.0		5.5						46.8	7.8	
Mabroom	0.8	0.6	15.3	11.7			3.0						47.2	8.5	
Barny	0.5	0.5	13.8	12.2	12.1								46.8	10.1	
Rotanah Alshara	0.5	0.5	14.5	11.9	11.1		4.1						47.4	9.2	
Lobanah Masery	0.5	0.5	13.1	10.7			4.1						49.0	8.5	
Shorcy	0.6	0.4	14.4	11.8			3.3						48.8	7.9	
Bamy	0.4	0.6	15.0	12.6			3.9						47.1	7.2	
Tamriq	0.0	0.0	13.1	11.1			2.8						52.8	7.1	

*Caproic 0.5. **Includes α-linolenic and γ-linolenic acids.

Table 6. Fatty acid content of date flesh (g/100 g)

	Range
Saturated fatty acid	
C12:0	0.6–5.4
C14:0	0.3–2.3
C16:0	1.7–1.8
C17:0	0.01
C18:0	0.3–0.7
C20:0	0.01
Unsaturated fatty acid	
C18:1(9)	3.2–5.1
C18:2(6,9)	0.7–0.8

Data from Al-Showiman (1990).

For example, aspartic acid, threonine, serine, glutamic acid, proline, glycine and alanine are found almost exclusively in dates; isoleucine is present in dates at over 800 times the quantity in apples. The lysine content of dates is nearly 2000 times that found in apples, nearly 5000 times that in oranges and over 2000 times that in bananas (Al-Showiman, 1998). There are at least 16 amino acids in the seeds of date (Table 9).

Auda *et al*. (1976) indicated that the protein concentration of three varieties (*Khastawi*, *Khadhrawi* and *Zahdi*) was highest at the green Kimri stage of ripening. The average concentration of 17 types of amino

Table 7. Mineral content of date flesh and seeds

		Varietal source and reference		
Mineral	*Concentration (mg/100 g dry date)*	*Maximum*	*Minimum*	*Nutrient intake (mg/day*)*
Flesh				
Boron	3.3–5.6	*Rothan* (1)	*Barhi* (1)	–
Calcium	9.5–207	*Lulu* (2)	*Zhadi* (3)	700
Cobalt	0.8–1.0	*Hallawi* (3)	*Khadrawi* (3)	0.3–1.5
Copper	0.1–2.9	*Khuneizy* (2)	*Sayer* (3)	1.2
Fluorine	0.1–0.2	*Zahdi* (3)	*Hallawi* (3)	1.8
Iron	0.3–10.4	*Barhi* (2)	*Zahdi* (3)	8.7
Magnesium	47–82	*Naghal* (2)	*Barhi* (2)	300
Manganese	0.3–5.9	*Khalas* (2)	*Hallawi* (3)	4.6
Potassium	107.4–916	*Bushibal* (4)	*Hilali Ahmr* (2)**	
Phosphorus	13–63	*Sayer* (3)	Not given (5)	550
Selenium	0.1–0.3	*Monifi* (1)	*Salaj* (1)	0.075
Sodium	1–287	Not given (5)	*Naghal* (2)	1600
Zinc	0.1–1.8	*Hilali Ahmr* (2)	*Sayer* (3)	9.5
Seeds				
Boron	2.4–3.2	*Rothan* (1)	*Sekkari* (1)	
Aluminum	0.03–0.24	*Khalas* (9)	*Sukkari* (9)	
Cadmium	0.01–0.09	*Fana* (8)	*Sukkari* (9)	
Calcium	0.2–155.5	*Khalas* (9)	*Gash Gaafar* (10)	
Copper	0.03–1.2	*Negeeb* (9)	*Shahla* (10)	
Chloride	161	Not given (12)		
Iron	0.05–31.6	*Negeeb* (9)	*Gondela* (11)	
Lead	0.001–0.04	*Sugee* (9)	*Sukkai* (9)	
Magnesium	0.1–132.8	*Sukari* (9)	*Gash Gaafar* (10)	
Manganese	1.4–2.3	*Shahla* (10)	*Bushibal* (10)	
Potassium	0.3–538.5	*Sukkari* (9)	*Gash Habash* (10)	
Phosphorus	104.4–181.1	*Shahla* (1)	*Lulu* (10)	
Sodium	1.7–8.1	*Fankha* (8)	*Taleese* (12)***	
Zinc	0.07–4.9	*Nabt-Saif* (9)	*Gash Habash* (10)	

*Nutrient intake for minerals as mg/day (Anonymous, 1991). **1359 in date palm pulp (Al-Showiman, 1990). ***28.2 in date palm pulp (Al-Showiman, 1990).
References: (1), Al-Showiman (1998); (2) Ahmed & Ahmed (1995); (3) Yousif *et al*. (1982); (4) Al-Hooti *et al*. (1995); (5) Considine (1982); (6) Anonymous (1991); (7) Al-Showiman (1990); (8) Salah-ud-Din *et al*. (1995); (9) Mossa *et al.* (1986); (10) Al-Hooti *et al*. (1998); (11) Shinwari (1993); (12) El-Shurafa *et al*. (1982).

Table 8. The effect of stage of ripening on the mineral content of dates in two different varieties

	Stage of ripening (mg/100 g dry date)			
Mineral	*Kimri stage*	*Khalal stage*	*Rutab stage*	*Tamr stage*
Lulu cultivar				
Calcium	38.7	48.6	74.3	36.3
Copper	0.4	0.5	0.4	0.9
Iron	4.2	1.2	1.1	6.8
Magnesium	132.7	59.0	74.3	46.1
Phosphorus	152.2	67.4	84.9	53.9
Potassium	633.2	484.2	350.3	128.8
Sodium	9.7	5.9	4.6	5.4
Zinc	1.6	0.4	0.7	0.3
Bushibal cultivar				
Calcium	142.4	75.4	76.3	37.8
Copper	0.3	0.2	0.4	0.3
Iron	8.1	1.5	1.0	0.9
Magnesium	121.0	74.9	65.4	53.2
Phosphorus	117.2	132.4	87.2	53.3
Potassium	752.6	510.1	338.1	107.4
Sodium	7.0	17.4	10.9	2.5
Zinc	1.0	0.5	0.8	0.4

Data from Al-Hooti *et al*. (1995).

acids found in these dates decreased as they ripened, but many of the amino acids have higher concentration at the yellow Khalal stage than the green stage (Table 9). Free and total glutamic acid are at their highest concentration in the three stages, but free aspartic acid concentration is higher in the second stage.

Vitamin content

Dates contain at least six vitamins (Table 10). The concentration of vitamin C (ascorbic acid) is low at 0.002–0.02% but B_1 thiamine, B_2 riboflavin, nicotinic acid (niacin), and vitamin A are also present.

Fibre content

We have found that the dietary fibre contents of 14 varieties of date from Iraq, Iran, Egypt and Saudi Arabia are as high as 6.4–11.5% depending on the variety of date (Al-Shahib & Marshall, 2002) (Table 11). This could be of particular importance to health in regions where dates are consumed in greater quantities than in the UK. Considerable research has been conducted in the past 30 years on the role of dietary fibre in health and disease. A low intake of dietary fibre is associated with a high incidence of colon cancer, heart disease, diabetes and other diseases/disorders (Anonymous, 1987). Further research is required see whether the fibre content of dates has similar beneficial effects on health.

Dates contain 0.5–3.9% pectin (Fayadh & Al-Showiman, 1990). It has been shown that pectin and pectin-containing foods reduce metabolic risk factors associated with heart disease and diabetes (Anonymous, 1987). It is useful in reducing the cholesterol level in the body.

El-Zoghbi (1994) pointed out that the percentage of pectin in dates decreases from stage 1 (1.58/100 g tissue) to 0.54% in stage 4, the dried date. The hemicellulose content also decreases from 5.25 to 1.29% from stage 1 to stage 4, while the cellulose content also decreases from 3.4 to 1.4%. The lignin content decreases from 3.5 to 0.3% and the total fibre content decreases from 13.7% in green date, stage 1, to 3.6% in the black date, stage 4. The pectinesterase activity in date increases during ripening stages to reach 60.8 units/100 g tissue, which explains the loss of pectin. This value is higher than that of mango, guava and strawberry (El-Zoghbi,

Table 9. Amino-acid content of date flesh and seeds

	Amino acid (mg/100 g dry date) (data from Hussein & El-Zeid, 1975)*	*Amino acid (g/100 g protein)** (data from Al-Hooti et al., 1998)*
Seeds		
Alanine	61	
Arginine	35	6.6–8.3
Aspartic acid	174	
Aspartamine	174	
Glutamic acid	172	
Glycine	92	
Histidine		2.3–2.4
Isoleucine		3.7–4.2
Leucine		7.8–8.6
Leucine and isoleucine	105	
Lysine	32	4.6–5.4
Methionine		0.9–1.2
Phenylalanine		4.3–4.7
Serine	58	
Threonine	50	3.7–4.1
Tryptophan	39	
Tyrosine	58	1.9–2.3
Valine	31	5.5–5.9

	Range	*Reference*	*Nutritional Requirements*****
Flesh***			
Alanine	8–342	1, 2, 3, 4	
Arginine	2–261	1, 2, 3, 4	
Aspartamine	230–450	2	
Aspartic acid	2–467	1, 2, 3, 4	
α-Amino butyric acid	266–337	2	
Cysteine	11–114	2	
Cytine	0.73–122	1, 2	
Glutamine	65–87	2	
Glutamic acid	40–631	1, 2, 3, 4	
Glycine	4–349	1, 2, 3	
Histidine	0.1–76	1, 3	
Isoleucine	0.2–465	1, 2, 3	14
Leucine	0.5–264	1, 3	29
Leucine and isoleucine	254	3	
Lysine	3–282	1, 2, 3, 4	12
Methionine	0.2–219	1, 2, 3	13
Phenylalanine	0.8–173	1, 3	29
Proline	12–369	1, 2, 5	
Serine	6–238	1, 2, 3	
Threonine	1–264	1, 2, 3, 4	7
Tryptophan	100	4	
Tyrosine	1–181	1, 2, 3, 4	29
Valine	0.5–271	1, 2, 3, 4	14

*The amino-acid content of *Khalas* cultivar as milligrams per 100 mg dry seeds.
**The range of amino-acid content of five seeds of *Bushibal*, *Gash Gaafar*, *Gash Habash*, *Lulu* and *Shahla* cultivars as grams per 100 g protein.
***The results depend on the type of date and the process of measurement. The data is measured as milligrams/100 g dry date. It is as milligrams of total amino acid, free amino acid or conjugated amino acid per 100 mg of dry date.
****Estimated amino acid requirements for daily intake nutrient (mg/kg per day) from Anonymous (1985).
References: 1, Considine (1982); 2, El-Sayed & Basseshim (1982); 3, Auda *et al*. (1976); 4, Hussein & El-Zeid (1975); 5, Anonymous (1986); 6, Anonymous (1985); 7, Al-Hooti *et al*. (1998).

Table 10. Vitamin content of dates

Vitamin	*Content (mg/100 g dry date)*	*Reference*	*Recommended nutrient intake for vitamins** (mg/day)*
Ascorbic acid (vitamin C)	2.4–17.5	1	40
Folic acid (folacin)	0.004–0.007	1	0.2
Nicotinic acid	0.002*	2	13
(Niacin)	0.0004–0.0007	3	
Riboflavin (vitamin B_2)	0.13–0.17	1	1.1
Thiamine (vitamin B_1)	0.08–0.13	1	0.8
Thiamine (vitamin B_1)	0.0002–0.0005	3	
Vitamin A	0.001*	4	0.6

*mg/100 g fresh date. **For men and women aged 19–50 years, data from Anonymous (1991).
References: 1, Yousif *et al*. (1982); 2, Considine (1982); 3, Khatob *et al*. (1982); 4, Sawaya *et al*. (1982a,b); 5, Anonymous (1991).

1994). The cellulase activity of dates also increases during ripening and it is two to four times higher than in other fruits (El-Zoghbi, 1994).

World production and exports of dates

The world production of dates from 1961 to 1970 increased by 1.06% from 1.8 million metric tones (mMT) to 1.9 mMT (Anonymous, 2001). In the following 10 years, the production increased by 1.42% to 2.7 mMT. During 1980–1990, production increased by 1.26% to 3.4 mMT. The 1990s showed a bigger increase in world production by 1.53% to 5.2 mMT in 1999. Therefore, world production of dates has increased 2.9 times over 40 years (Table 12) compared with the doubling of total world population.

The total world export of dates increased by 1.71% from 0.28 mMT in 1961 to 0.48 mMT in 1999; thus, most of the dates are used for local consumption. Iraq exported 66% of total world production in 1961, whereas in 1999 it exported 6% of the world total due to sanctions imposed by the United Nations (Table 12). By contrast, The Islamic Republic of Iran exported 9% of the world total in 1961, whereas in 1999 it exported 21% of the total. The production of dates in Iran in 1999 was 0.9 mMT (17.5% of world production). The United Arab Emirates produced 0.006 mMT of dates in 1961 (0.3% of world production) and 0.3 mMT in 1999 (5.9% of world production), and exported 0.2 mMT (64% of its production and 40% of the world total). This indicates that the United Arab Emirates succeeded in finding markets for its date production to meet 40% of the world demand. This suggests that the market for dates could be increased significantly in the future.

Conclusions

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, six vitamins and a high percentage of dietary fibre. However, there are a number of inconsistencies in published data. For example, fibre content has been measured by a variety of methods including 'crude fibre', which is does not give results that represent dietary fibre 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

Table 11. Fibre content of dates and method of determination

Variety of date	*Fibre (% w/w)*	*Method of determination*	*Reference*
Unspecified varieties	3.6	Unspecified	1
	4.4	Unspecified	2
	2.2–8.3	Unspecified	3
	6.9	Enzymatic method	4
Specific varieties			
Anbarah	8.5	Fibertec system	5
Bamy	6.4	Fibertec system	5
Bushibal	2.6	Crude fibre	6
Gash Gaafar	2.9	Crude fibre	6
Gash Habash	3	Crude fibre	6
Hallawi	1.8	Crude fibre	7
Hallawi & Sayer	8	Enzymic method	8
Khadrawi	2.3	Crude fibre	7
Lobanah Masery	11.4	Fibertec system	5
Lulu	2.1	Crude fibre	6
Mabroom	8.5	Fibertec system	5
Rabeaah	9.7	Fibertec system	5
Rotanah alshara	9.7	Fibertec system	5
Safawi	3.1	Crude fibre	9
Safawy	6.7	Fibertec system	5
Sakhi	4.6	Crude fibre	9
Sayer	1.7	Crude fibre	7
Shahla	2.4	Crude fibre	6
Shalabi	3.9	Crude fibre	9
Shalaby	10.4	Fibertec system	5
Shorcy	5.6	Fibertec system	5
Sofry	7.7	Fibertec system	5
Sukkari	4	Crude fibre	9
Sukkary	8.2	Fibertec system	5
Suqaey	8	Fibertec system	5
Tamriraq	10.9	Fibertec system	5
Zahdi	2.5	Crude fibre	7

References: 1, El-Zoghbi (1994); 2, Anonymous (1993); 3, Al-Showiman (1998); 4, Lund *et al*. (1983); 5, Al-Shahib & Marshall (2002); 6, Al-Hooti *et al*. (1995); 7, Yousif *et al*. (1982); 8, Al-Mukhtar (1994); 9, Shinwari (1993).

were 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 fibre (Al-Shahib & Marshall, 2002) as well as other essential nutrients.

Present production amounts to no more than 1 kg/person per year. The world pro-

Table 12. World production and major exporters of dates, 1961 and 1999

	Production (1000 MT)				*Export (1000 MT)*			
Country	*1961*	*% of world*	*1999*	*% of world*	*1961*	*% of world*	*1999*	*% of world*
United Arab Emirates	6	0.3	305	5.9	1	0.3	195	40.4
Saudi Arabia	160	8.6	712	13.7	3	1	25	5.2
Iran, Islamic Republic of	300	16.2	908	17.5	26	9.1	101	20.9
Iraq	350	18.9	438	8.4	187	66	30	6.2
Egypt	479	25.9	906	17.5	1	0.3	4	0.8
World	1852		5190		260		467	

duction 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.

Demand for dates could be increased significantly if nutrition education was improved and availability was increased. This could help these countries to avoid some of the health problems seen in developed countries. Promotions of the health-giving benefits of dates in the developed countries also aid governments in meeting nutrition targets. Education about the importance of dates could bring significant health benefits. Improvements in the packaging and labelling of dates in addition to the presentation of delicious dates in the market are also important steps towards marketing dates as a complete food.

The chronic diseases appearing in humans may be due to excessive consumption of high fat, low fibre and refined foods typical of the diet in Europe and the USA. These diseases are beginning to appear in developing countries as they tend to adopt similar lifestyles and eating habits. We can also speculate that dates may have other, as yet unknown, health and medical benefits.

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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