

## Physicochemical properties and applications of date seed and its oil

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### Abstract

The date (*Phoenix dactylifera* L.) is an important agricultural crop in most of the Middle East countries and it is a staple food for millions of people in this part of the world. Date seeds, also called pits, kernels, stones or pips, are a waste product of date processing and packing plants. Therefore, date seeds have been a problem to the date industry, while they contain many valuable substances such as carbohydrates, oil, dietary fiber, protein, bioactive polyphenols and natural antioxidants. However, date seeds can be used for many applications like food products formulation, cosmetics and functional and medicinal supplements. This article reviews physical properties and chemical composition of date seed powder and date seed oil. Particular attention has been also paid to the different applications of date seed powder and its oil.

### Keywords

Date seed

Date seed oil

Fatty acid composition

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### Introduction

Date palm plays an important role in the economic and social life of the people in the date producing countries (Basuni and AL-Marzooq, 2010). The fruit of the date palm is composed of a fleshy pericarp and seed that is usually oblong, ventrally grooved, with a small embryo and a hard endosperm. Date seeds constitute 10-15% of the date fruit weight. The seed characteristics of date varieties vary according to variety and environmental conditions. Soil fertilization (Basha and Abo-Hassan, 1982), irrigation, daily temperatures, duration of the growing period and other post-harvest treatments (further drying or moistening of the fruit) are the factors which can affect on physical properties of the date fruits. It is conceivable that these factors are also likely to affect those of the date seeds (Habib and Ibrahim, 2009). The length, width and weight of the seeds range from 1.2-3.6 cm, 0.6-1.3 cm and 0.5-4 g, respectively (Al-Farsi and Lee, 2011). According to Amira *et al.* (2011), the weight of date fruits of Allig, Degla, Deglet Nour, Gosbi and their seeds decrease during maturity stages. The world production of dates was 7.5 million tons in 2011 (Guizani *et al.*, 2014), meaning that approximately 750 thousand tons of date seeds were produced during that year. A large number of date seeds are being obtained from the date industries or the waste products annually.

Date seeds contain high levels of valuable bioactive compounds (Al-Farsi and Lee, 2011) and dietary fiber which makes them suitable for the preparation of fiber-based foods (Hamada *et al.*, 2002). Therefore, utilization of this low cost agricultural by-product is important to date industry in the date producing countries. Many studies have been carried out on date seeds. These studies have been focused mainly on the chemical composition of date seeds (El-Rayes, 2009; Ardekani *et al.*, 2010; Basuni and AL-Marzooq, 2010). Some applications such as oil extraction from the date seeds and the use of the seeds and their constituents in cosmetics, pharmaceuticals and to a lesser degree in formulation of food products have been also reported which will review in this paper. Information on chemical composition and nutritional quality of the date seed and its oil will enhance our knowledge to use this by-product in some food and specialty products.

### Date seed

#### Chemical composition of date seed

Many studies have been conducted on composition of the date seeds from various parts of the world. Saafi *et al.* (2008) reported that the seeds of a mixture of some mature common date varieties called "Khalti" contained 6.88% moisture, 8.12% total sugars, 6.63% reducing sugars, 1.49%

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Table 1. The seed composition of different date varieties

| Date varieties                                  | Chemical Composition (%) |       |         |      |                    | References              |
|---|--------------------------|-------|---------|------|--------------------|-------------------------|
|   | Moisture                 | Fat   | Protein | Ash  | Total Carbohydrate |                         |
| Fard (UAE)                                      | 10.3                     | 9.9   | 5.7     | 1.4  | -                  | Hamda et al., 2002      |
| Khalas (UAE)                                    | 7.1                      | 13.2  | 6.0     | 1.8  | -                  | Hamda et al., 2002      |
| Lulu (UAE)                                      | 9.9                      | 10.5  | 5.2     | 1.0  | -                  | Hamda et al., 2002      |
| <i>Phoenix canariensis</i> seeds (Saudi Arabia) | 10.2                     | 10.36 | 5.67    | 1.18 | 72.59              | Nehdi et al., 2010      |
| Allig (Tunisia)                                 | -                        | 12.67 | 5.17    | 1.12 | 81.0               | Besbes et al., 2004a    |
| Deglet Nour (Tunisia)                           | -                        | 10.19 | 5.56    | 1.15 | 83.1               | Besbes et al., 2004a    |
| Khalti (Tunisia)                                | 6.88                     | 8.33  | 5.31    | -    | -                  | Saafi et al., 2008      |
| Ruzeiz  | 5.4                      | 10.2  | 6.8     | 1.1  | 61.5               | Sawaya et al., 1984     |
| Sifri   | 5                        | 10.4  | 6.5     | 1.1  | 58.5               | Sawaya et al., 1984     |
| Date seed powder (Oman)                         | -                        | 8.08  | 7.08    | 0.98 | 62.31              | Rahman et al., 2007     |
| kabkab & shahani (Iran)                         | 10.5                     | 12.59 | 5.56    | 1.35 | 80.65              | Amir Azodi et al., 2014 |
| Rajshahi (Bangladesh)                           | 5-10                     | 7-10  | -       | 1-2  | 55-65              | Joardder et al., 2012   |
| Mabseeli (sun-dried, Oman)                      | 3.14                     | 5.02  | 3.92    | 1.03 | 86.89              | Al-Farsi et al., 2007   |
| Um-sellah (sun-dried, Oman)                     | 4.4                      | 5.9   | 5.4     | 1.16 | 83.14              | Al-Farsi et al., 2007   |
| Shahal (sun-dried, Oman)                        | 5.19                     | 5.09  | 2.29    | 0.89 | 86.54              | Al-Farsi et al., 2007   |

sucrose, 5.31% protein and 8.33% fat. The following values were also obtained for Deglet Nour and Allig cultivars, respectively: protein 5.56 and 5.17%, fat 10.19 and 12.67%, ash 1.15 and 1.12% and total carbohydrate 83.1 and 81.0% (Besbes et al., 2004a). According to Amir Azodi et al. (2014), the seeds of Kabkab and Shahani date varieties from Bushehr, Iran consisted of 10.50% moisture, 5.56% of protein, 12.59% of lipid, 62.18% of soluble fiber in acidic solutions and finally 1.35% of ash. Also Amany et al. (2012) stated that the date seed was composed of 3.10-7.10% moisture, 2.30-6.40% protein, 5-13.20% fat, 0.9-1.80% ash and 22.50-80.20% dietary fiber. The seed composition of different date varieties from several studies are shown in Table 1. The differences may be due to the variability of the studied cultivars and also climatic conditions (Saafi et al., 2008). Abdul Afiq et al. (2013) reported that the fat content in date seeds depended on variety, origin, harvesting time and fertilizer. However, carbohydrate and fat are the main components in date seeds. The protein and fat content of the date seeds are relatively high in comparison with the date flesh (1.5-3% for protein and 0.1-1.4% for fat) (Al – Farsi and Lee, 2011). The protein of date seed contains the majority of essential amino acids (Al-Farisi and Lee, 2014) and has a relatively higher amount of sulphur amino acids (methionine, cystine) compare to other seed proteins (soybean, peanuts, cottonseed). Glutamic acid, aspartic acid and arginine compose about half of the total amino acids recovered from the seeds of Ruzeiz and Sifri date cultivars. Tryptophan is the first limiting amino acid in date seed proteins. Date seeds

also contain a higher concentration of lysine (Sawaya et al., 1984). The soluble proteins (albumin, globulin, glutelin) are also detected in date seeds (Abdul Afiq et al., 2013).

Date seeds are a very good source of dietary fiber, which was reported as 77.8–80.2 g/100 g fresh weight (Al-Farsi et al., 2007) or 64.5-80.15 g/ 100 g fresh weight (Al-Farsi and Lee, 2011). Abdul Afiq et al., (2013) stated that the total dietary fiber in date seeds was 58%, with 53% of it was insoluble dietary fiber (hemicellulose, cellulose and lignin). Hamada et al. (2002) reported that the seeds from three date varieties (Fard, Khalas, Lulu) in UAE contained 46-51% acid detergent fiber and 65-69% neutral detergent fiber, indicating the high level of lignin and resistant starch. These differences in dietary fiber are related to maturation stage and variety. The phytic acid concentration was small in comparison with cereal grains and oil seeds (Hamada et al., 2002). The beneficial effects of dietary fiber include prevention against hypertension, coronary heart disease, high cholesterol, cancers and intestinal disorders (Tariq et al., 2000; Al-Farsi and Lee, 2011; Hejri Zarifi et al., 2012). Therefore, date seed powder can have therapeutic implications for diabetes, obesity, and hyperlipidemia. Almana and Mahmaud (1994) suggested that date seed may provide a valuable contribution to dietary fiber intakes.

Date seeds are reported to contain many minerals such as sodium, potassium, magnesium, calcium, phosphorus, iron, manganese, zinc, copper, nickel, cobalt, chromium, lead and cadmium (Abdillah and Andriani, 2012; Abdul Afiq et al., 2013). Potassium,

Table 2. Minerals in various date seeds

| Date varieties                       | Minerals (mg/ 100g seed) |               |            |          |           |             |           |          |               |
|--------------------------------------|--------------------------|---------------|------------|----------|-----------|-------------|-----------|----------|---------------|
|                                      | Na                       | P             | Ca         | Fe       | Cu        | Mg          | Mn        | Z        | P             |
| <sup>1</sup> Bahraini dates          | 21.7-16.5                | 459.90-542.20 | 6.50-11.30 | 2.90-6.0 | 0.40-0.60 | 61.30-69.60 | 1.30-1.70 | 1.0-1.50 | -             |
| <sup>2</sup> Date seed powder (Oman) | 16.50                    | 254.09        | 19.17      | 2.13     | 0.53      | 78.94       | 0.61      | 0.15     | 130           |
| <sup>3</sup> 18 date Varieties (UAE) | 7.20-15.40               | 175.0-240.50  | 13.40-34.0 | 1.30-5.0 | 0.10-0.60 | 58.80-89.70 | 0.60-1.30 | 1.0-1.6  | 110.10-146.80 |
| <sup>4</sup> Roasted dates           | 16.50                    | 254.10        | 19.20      | 2.13     | 0.50      | 78.90       | 0.60      | 0.20     | 30.0          |
| <sup>5</sup> Deglet Nour date        | 10.40                    | 229.0         | 38.80      | 2.30     | -         | 51.70       | -         | -        | 68.30         |
| <sup>6</sup> Allig date              | 10.25                    | 293.0         | 28.90      | 2.21     | -         | 58.40       | -         | -        | 83.60         |
| <sup>7</sup> Khabs                   | 160.0                    | 2489.50       | 189.35     | 19.2     | 5.02      | 811.30      | 7.12      | 1.67     | 1256.23       |
| <sup>8</sup> Sifri                   | 33.40                    | 311.20        | 49.60      | 7.40     | 1.0       | 65.70       | 2.30      | 1.40     | 115.30        |
| <sup>9</sup> Ruzeiz                  | 28.0                     | 294.50        | 48.20      | 7.40     | 1.30      | 60.80       | 3.30      | 2.30     | 113.90        |
| <sup>10</sup> Phoenix Canariensis    | 8.77                     | 255.43        | 48.56      | 3.21     | -         | 62.78       | -         | -        | 41.33         |

<sup>1</sup>Ali-Mohamed and Khamis, 2004; <sup>2</sup>Rahman et al., 2007; <sup>3</sup>Habib and Ibrahim, 2009; <sup>4</sup>Rahman et al., 2007; <sup>5,6</sup>Besbes et al., 2004a; <sup>7</sup>Amany, 2012; <sup>8,9</sup>Sawaya et al., 1984; <sup>10</sup>Nehdi et al., 2010.

Table 3. Comparison of minerals ( $\mu\text{g/g}$ ) in coffee, barley with Bahraini date seeds (adopted from Ali-Mohamed and Khamis, 2004)

|            | Na <sup>+</sup> | K <sup>+</sup> | Mg <sup>2+</sup> | Ca <sup>+</sup> | Fe <sup>2+</sup> | Mn <sup>2+</sup> | Zn <sup>2+</sup> | Cu <sup>2+</sup> | Ni <sup>2+</sup> | Co <sup>2+</sup> | Pb <sup>2+</sup> | Cd <sup>2+</sup> | TEBMI <sup>a</sup> | TMI <sup>a</sup> |
|------------|-----------------|----------------|------------------|-----------------|------------------|------------------|------------------|------------------|------------------|------------------|------------------|------------------|--------------------|------------------|
| Date seeds | 237.63          | 4857.58        | 655.53           | 95.12           | 44.47            | 14.82            | 12.24            | 5.24             | 1.12             | 0.79             | 1.11             | 0.03             | 5845.87            | 10167.29         |
| barely     | 291.78          | 5091.24        | 1067.77          | 223.27          | 25.27            | 13.18            | 26.41            | 2.71             | 4.25             | 4.92             | 6.27             | 0.18             | 6674.07            | 13284.83         |
| Coffee     | 48.55           | 19607.30       | 1759.03          | 566.66          | 26.32            | 32.04            | 6.33             | 13.42            | 8.28             | 0.60             | 6.92             | 0.46             | 21981.56           | 22075.95         |

<sup>a</sup>TEBMI: Total Essential Bulk Metal Ions; TMS: Total Metal Ions.

phosphorus, magnesium, calcium and sodium are there in higher concentrations in date seeds (Al-Hooti *et al.*, 1998; Devshony *et al.*, 1992, Besbes *et al.*, 2004a). Iron and then manganese, zinc and copper are also found in higher concentrations among the microelements (Sawaya *et al.*, 1984). According to Attalla and Harraz (1996), the seeds of 11 date cultivars in Qassim region of Saudi Arabia contained small amounts of phosphorus (0.19-0.26%). Selenium is another component that may be present in date seeds. The selenium level of 10 date varieties grown in Saudi Arabia was in the range of 1.48-2.96 mg/g (Al-Showiman *et al.*, 1994). The concentration of selenium in some date varieties is high which it can be due to the selenium content of the soil (Al-Farsi and Lee, 2011). The minerals in various date seeds are presented in Table 2. As it is shown, date seeds are a good source of minerals. Ali-Mohamed and Khamis (2004) compared the mineral ion concentrations of coffee, barely and Bahraini date seeds. The total mineral ion content of coffee was the highest, followed by barely and then the date seeds (Table 3). They concluded that the mineral ion

concentrations of date seeds were within the dietary intake level in humans. However, the low amount of nickel in date seed in comparison with coffee and barely makes it suitable for food or animal feed (Ali-Mohamed and Khamis, 2004).

Date seeds are an excellent source of phenolic compounds (3102-4430 mg gallic acid equivalents/100g fresh weight) and antioxidants (580-929  $\mu\text{mol}$  trolox equivalents/g fresh weight) (Al-Farsi *et al.*, 2007). Date seed oil has higher phenol content than most edible oils except olive oil (Besbes *et al.*, 2005). Guizani *et al.* (2014) reported that Polyphenol contents in date seeds were in the range of 21-62 mg gallic acid equivalents/g date seed, when acetone-water, ethanol-water, methanol-water and water alone were used as solvents for extraction at temperatures 22, 45, and 60°C. According to Ardekani *et al.* (2010), Iranian date seed varieties had a relatively high antioxidant activity and were strong radical scavengers that could be used for medicinal and commercial purposes. Gallic acid, protocatechuic acid, *p*-hydroxybenzoic acid, vanillic acid, caffeic acid, *p*-coumaric acid,

ferulic acid, *m*-coumaric acid and *o*-coumaric acid were identified in date seeds (Abdul Afiq *et al.*, 2013). Among them, *p*-hydroxybenzoic acid (9.89 mg/100g), protocatechuic acid (8.84 mg/100g), and *m*-coumaric acid (8.42 mg/100g) were the major phenolic acids (Al-Farsi and Lee, 2008). Amany *et al.* (2012) investigated the effect of date seed phenolic compounds on lipid oxidation and quality of ground beef during refrigeration. The results showed that phenolic compounds in the seeds of khalas date could reduce the formation of hydroperoxides during storage.

#### *Applications of date seed*

In most date producing countries, date seeds are discarded or used on a small scale as animal feed (Devshony *et al.*, 1992; Saafi *et al.*, 2008; Habib *et al.*, 2013). Date seeds are used sometimes as a soil organic additive (Guizani *et al.*, 2014). They are also a good precursor for production of activated carbon (Joardder *et al.*, 2012). Date seeds have many food applications and can be added to several food products. Recently, date seed powder, as a coffee substitute, has been introduced to the market in the forms of plain and blended with coffee (Devshony *et al.*, 1992; Habib *et al.*, 2013). Al-Farisi and Lee (2014) enriched date paste with seed powder to increase nutritional quality and to improve firmness of the date paste. The enriched date paste with 3% dry seed powder was the best formulation and had no negative effect on sensory properties of the product (Al-Farisi and Lee, 2014). Few researches have been carried out on incorporation of date seed powder into wheat flour for bread production. According to Halaby *et al.* (2014), pan bread containing 15% date seed had the highest score in overall acceptability when compared to control and other levels of seeds. They also concluded that date seed powder had improving effect on the nutritive value of pan bread and also it had a hypoglycemic effect and could decrease the risk of diabetic diseases. It is reported that Saudi Mafrood flat breads containing 10% coarse seed powder had similar sensory properties to flat breads containing wheat bran. Flat breads containing fine seed powder had lower sensory scores (color, flavor, odor, overall acceptability) than wheat bran controls (Habibi Najafi, 2011). Hejri-Zarifi *et al.* (2013) milled date seeds into germ and residue and incorporated them in formulation of Iranian Barbari flat bread at the levels ranged in 0.5-3 g/100 wheat flour. The results of texture analysis during 5 days of bread storage showed that both fractions of germinated date seeds reduced the bread staling. The higher levels of flavonoids and antioxidant capacity

were observed in Arabic bread containing date seed powder (Platat *et al.*, 2013).

Date seed powder is used for addition to animal feed (cattle, sheep, camel, and poultry) and fish feed. Incorporation of date seed into animal diet is reported to enhance growth, improve feed efficiency and also meat palatability (Elgasim *et al.*, 1995; Hussein *et al.*, 1998; Al-Farsi and Lee, 2011;). It is claimed that date seeds are a good source of slow-release energy for camels (Al-Farsi and Lee, 2011).

The use of date seed powder in traditional medicines and utilization of it in the production of citric acid and protein by *Candida lipolytica*, *Apergillus oryzae* and *Candida utilis* were also reported (Jassim and Naji, 2010). It is stated that date seeds have the antimicrobial activity and only an ethanolic extract of date seeds has been shown a week antimicrobial activity on some microorganisms (Jassim and Naji, 2010). In another study, the date seed extracts could inhibit the infectivity of Pseudomonas phage ATCC 14209-B1 and as a result, Jassim and Naji (2010) stated that date seed extracts had a potential as a novel antiviral agent against pathogenic human viruses.

#### **Date seed oil**

##### *Physical and chemical properties*

There is a significant quantity of carotenoid pigment in date seed oil and it makes its color a very intense yellow (Saafi *et al.*, 2008). Hsu and Yu (2002) stated that date seed oil was more yellow-colored than soybean oil, sunflower oil, olive oil and corn oil. However, the color of date seed oil varies from green-yellow to brown-yellow (Boukouada and Yousfi, 2009) or pale-yellow and it is semi-solid (Devshony *et al.*, 1992). The viscosity of Deglet Nour seed oil and Allig seed oil has been reported 20 mpa s and 40 mpa s, respectively. However, the fatty acid content of medium and short chain in Deglet Nour seed oil is high in compare to Alligh seed oil. The viscosity of most vegetable oils is in the range of about 50-100 mpa s (Besbes *et al.*, 2005). The following average characteristics have been reported for seed oil of four date cultivars (Zahidi, Medjool, Halawy, Deglet Nour): acid value 1.04, iodine value 49.5, saponification value 221, and unsaponifiable matter 0.8% (Devshony *et al.*, 1992). The mean of values for the seed oil of three Iranian date varieties (Kabkab, Shekar, Shahabi) were: peroxide value 1.05, acid value 1.04, *p*-anisidine value 2.54, totox 4.64 and refractive index 1.46. The physical and chemical properties of two Sudanese date seed oil (Albarakavi, Alqundeila) were also studied by Mahmoud Abdalla *et al.* (2012). The viscosity,



Table 4. Fatty acid composition (wt %) of seed oils from different date varieties

| Date varieties  | Capric<br>(10:0) | Lauric<br>(12:0) | Myristic<br>(14:0) | Palmitic<br>(16:0) | Stearic<br>(18:0) | Oleic<br>(18:1) | Linoleic<br>(18:2) | Linolenic<br>(18:3) |
|---|------------------|------------------|--------------------|--------------------|-------------------|-----------------|--------------------|---------------------|
| <sup>1</sup> Deglet Nour                                      | 0.8              | 17.8             | 9.84               | 10.90              | 5.67              | 41.30           | 12.40              | 1.68                |
| <sup>2</sup> Allig  | 0.07             | 5.81             | 3.12               | 15.0               | 3.00              | 47.70           | 21.00              | 0.81                |
| <sup>3</sup> Phoenix<br>Canariensis                           | 0.11             | 10.24            | 7.51               | 9.83               | 1.66              | 50.00           | 19.23              | 0.11                |
| <sup>4</sup> 14 Date varieties<br>(Iran)                      | NR               | 24.31            | 13.27              | 10.40              | 2.30              | 42.12           | 6.46               | NR                  |
| <sup>5</sup> Khalti   | NR               | 17.39            | 10.06              | 10.20              | 3.06              | 47.66           | 10.54              | 0.46                |
| <sup>6</sup> Kabkab   | 0.50             | 25.68            | 13.27              | 11.90              | 2.34              | 37.61           | 6.93               | NR                  |
| <sup>7</sup> Shekar   | 0.49             | 30.51            | 16.76              | 13.08              | 1.85              | 31.48           | 4.41               | NR                  |
| <sup>8</sup> Shahabi  | 0.48             | 30.81            | 16.93              | 13.10              | 1.87              | 31.79           | 4.46               | NR                  |
| <sup>9</sup> Mordasang  | NR               | 22.06            | 11.91              | 11.18              | 3.34              | 42.72           | 8.78               | 0.01                |
| <sup>10</sup> Calculated<br>average for 18<br>Varieties (UAE) | NR               | NR               | 14.52              | 12.41              | 3.36              | 47.47           | 10.23              | 0.12                |
| <sup>11</sup> Albarakawi                                      | NR               | 37.10            | NR                 | 9.24               | 1.17              | 32.66           | 4.33               | NR                  |
| <sup>12</sup> Alqundeila                                      | NR               | 0.11             | NR                 | NR                 | 46.93             | ND              | ND                 | NR                  |
| <sup>13</sup> Khalas  | 0.25             | 35.31            | 0.04               | 12.58              | 3.30              | 39.50           | 8.20               | 0.81                |

NR: Not reported; <sup>1,2</sup> Besbes *et al.*, 2005; <sup>3</sup> Nehdi *et al.*, 2010; <sup>4</sup> Biglar *et al.*, 2012; <sup>5</sup> Saafi *et al.*, 2008; <sup>6,7,8</sup> Akbari *et al.*, 2012; <sup>9</sup> Ataye Salehi *et al.*, 2011; <sup>10</sup> Habib *et al.*, 2013; <sup>11,12</sup> Mahmoud Abdalla *et al.*, 2012; <sup>13</sup> Amany *et al.*, 2012

refractive index, and density were: 17, 20 cp; 1.444, 1.458; 0.9116 g cm<sup>-3</sup>, 0.9174 g cm<sup>-3</sup> for Albarakawi and Alqundeila, respectively. The study of the seed oil of three date varieties in Algeria (Deglet Nour, Ghars, Tamdjouhert) indicated that acid value ranged from 1.35-1.38 mg KOH/g. The saponification value, iodine value, refractive index, and specific gravity were 204.84-215.87, 67.22-74.80, 1.4778-1.4792, and 0.8836-0.9295, respectively.

A range of saturated and unsaturated fatty acids are there in seed oil of different date varieties. The main fatty acids in Zahidi, Medjool, Halawy, and Deglet Nour seed oils were oleic acid (42.3%) and lauric acid (21.8%), followed by myristic (10.9%), palmitic (9.6%) and linoleic acid (13.7%). Walid and Richard (2003) reported that the highest percentage of unsaturated and saturated fatty acids among the seed oils of 14 date cultivars were oleic acid and lauric acid with amounts of 49.8% and 24.1% in Suqaey and Rabeaah varieties, respectively. In the case of 5 date cultivars grown in the United Arab Emirates (Bushibal, Gash Gaafar, Gash Habash, Luhu, Shahla), the fatty acid content of the oils varied from 53.2-58.8% for oleic acid, 10.7-12.8% for linoleic acid, 10.6-13.8% for palmitic acid, 6.3-10.9% for lauric acid, 5.2-7% for myristic acid, 1.4-3.7% for stearic acid, 0.1-0.2% for linolenic acid, and 0.5-0.8% for arachidic acid (Al-Hooti *et al.*, 1998). Oleic acid (44.25%), lauric acid (17.35%), myristic acid (11.45), palmitic acid (10.30), and linoleic acid (8.45%) were the major fatty acids in the seed oil of Ruzeiz and Sifri date varieties (Sawaya *et al.*, 1984). Biglar *et al.* (2012) stated that Iranian date seed oils (Sayer, Khenizi, Majul, Shekar, Zahedi, Gofar, Khasuee) had more unsaturated than saturated fatty acids, but some minor differences were found in

the fatty acid profile among them due to the genetic variation. According to Besbes *et al.* (2005), Deglet Nour seed oil had higher saturated fatty acid content (~44.3%) than Allig seed oil (~26.3%). It is reported that the seed oil of 24 date cultivars contained 41-59% oleic acid (Abdul Afiq *et al.*, 2013). As shown in Table 4, the oleic, lauric, linoleic, and palmitic acids are the main fatty acids in date seed oil. Therefore, the date seed oil is a good source of oleic acid and the content of this fatty acid is almost similar to the oleic acid content found in rice bran oil and canola oil (Table 5) (Abdul Afiq *et al.*, 2013). It should be noted that the linoleic acid content of date seed oil is low in compare to the commonly consumed vegetable oils (Table 5) (Sawaya *et al.*, 1984). However, date seed oil may be regarded as an oleic-lauric oil (Devshony *et al.*, 1992; Biglar *et al.*, 2012;), while palm oil and palm kernel/ coconut oils are palmitic-oleic and lauric-myristic oils, respectively (Devshony *et al.*, 1992). Al-Hooti *et al.* (1998) stated that date seed oils were oleic-linoleic or oleic-palmitic types.

Habib *et al.* (2013) analyzed the seed oil of 18 date varieties cultivated in the UAE for fat soluble vitamins, carotenoids and fatty acid profiles.  $\beta$ -Carotene was the major carotenoid in all of the 18 date seed oil and ranged between 1.18 mg and 2.68 mg/100g. Date seed oils also contained considerable concentrations of vitamin E (1.01 mg and 1.86 mg/100g  $\alpha$ -tocopherol; 0.61 mg and 0.98 mg/100g  $\alpha$ -tocopherol acetate; 0.40 mg and 0.70 mg/100g  $\gamma$ -tocopherol) and vitamin K1 (0.10 mg and 0.19 mg/100g) (Habib *et al.*, 2013). The oxidative stability of date seed oil is comparable to that of olive oil due to low content of polyunsaturated fatty acids in date seed oil and olive oil (Besbes *et al.*, 2004). The total sterol content of the date seed oils were between

Table 5. Fatty acid composition (wt%) of oils from oilseeds (adopted from Gunstone, 2002)

| Fatty acid  |      | Olive oil    | Rice bran oil | Canola oil | cottonseed | Soybean oil |
|-------------|------|--------------|---------------|------------|------------|-------------|
| Lauric      | 12:0 | Not detected | Not reported  | -          | -          | -           |
| Myristic    | 14:0 | 0.0-0.1      | 0.4           | -          | 0.9        | 0.1         |
| Palmitic    | 16:0 | 7.5-20       | 19.8          | 3.9        | 24.7       | 11.0        |
| Palmitoleic | 16:1 | 0.3-3.5      | 0.2           | 0.2        | 0.7        | 0.1         |
| Stearic     | 18:0 | 0.5-5.0      | 1.9           | 1.9        | 2.3        | 4.0         |
| Oleic       | 18:1 | 55.0-83.0    | 42.3          | 64.1       | 17.6       | 23.4        |
| Linoleic    | 18:2 | 3.5-21.0     | 31.9          | 18.7       | 53.3       | 53.2        |
| Linolenic   | 18:3 | 0.0-1.5      | 1.2           | 9.2        | 0.3        | 7.8         |
| Arachidic   | 20:0 | 0.0-0.8      | 0.9           | 0.6        | 0.1        | 0.3         |

5.417 and 7.884 mg/g (Boukouada and Yousfi, 2009). However, the minor components in date seed oil are important for the functional properties of the oil such as oxidation resistance, color, taste, and also they can have health benefits.

#### Applications of date seed oil

There are some potential applications of the date seed oil in cosmetics (body creams, shaving soap, and shampoos), medicine (protector against herosclerosis), pharmaceuticals (liniment for indolent tumors) and food formulations (Mahmoud Abdalla *et al.*, 2012). According to Besbes *et al.* (2005), date seed oil was resistant to thermal treatment during about 30- 40h and so, it could be applied in culinary preparations (frying and cooking). Date seed oil has a high oxidative stability and can be stored safely during a long period. Date seed oil can protect skin against UV-A and UV-B lights which are responsible for cellular damage (Besbes *et al.*, 2004b) and also from the oxidative stress damage caused by hydrogen peroxide. In addition, date seed oil can repair the human skin due to its antioxidant activity. These specificities make it suitable for cosmetic and food industries (Abdul Afiq *et al.*, 2013). Fatma *et al.* (2009) supplemented sperm with date seed oil and found that the level of lipid peroxidation of spermatozoa added with date seed oil decreased and the capability of the sperm to fertilize the oocyte increased. In another study, the use of date seed oil was found to increase motility, viability, and the sperm count in mice (Abdul Afiq *et al.*, 2013).

The oil of date seed is edible but it is not competitive with other oil crops because of its low extraction rate (Boukouada and Yousfi, 2009; Al-Farsi and Lee, 2011). However, it contains natural antioxidants, carotenoids ( $\beta$  carotene), and some phytochemicals which may consider as an essential oil (Habib *et al.*, 2013). Basuny and Al-Marzooq (2010) used date seed oil in preparation of mayonnaise and compared this product with commercial mayonnaise obtained from corn oil. The results showed that

mayonnaise containing date seed oil was superior in sensory characteristics.

Another application of date seed oil can be in the production of biodiesel because it contains low free fatty acid (0.53%-1.05%) (Nehdi *et al.*, 2010). The oils with high free fatty acid content use more catalysts to balance their acidity (Abdul Afiq *et al.*, 2013). A study was conducted for the possibility of using date seed oil in soap production. According to the results, the addition of 30% or more date seed oil led to increase in the soap suds efficiency. All the soap samples were in accordance with the control regarding their effect on human skin (Ashour Ahmed, 1999). Antimicrobial activity of the date seed oil against *Escherichia coli*, alfa and beta *hemolytic streptococci*, *staphylococcus aureus*, and *Aspergillus fumigates* has been also reported (Ekpa and Ebana, 1996).

#### Conclusion

Date seeds are waste products from date industry which can serve as a source of edible oil. Date seeds can be also used as a functional food ingredient because they are a good source of dietary fiber, phenolic compounds and antioxidant activity. In addition, date seeds contain a considerable amount of food ingredients such as protein and minerals. Therefore, the potential uses of date seed in different industries are promising. Date seed presents a number of challenges. There is no report about the adverse effects of date seed oil, but more researches are needed to determine the safety of date seed oil as an ingredient in the food or cosmetic industries. Another challenge is the oil extraction process from date seeds whereas the seeds do not provide a high yield of oil. However, date seeds are available at low or no cost and the seed oil extraction may be feasible and worth consideration.

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