



Original research

Chemical composition of seed and seed oil from Iranian commercial date cultivars

Abolfazl Golshan Tafti^{a,*}, Bahman Panahi^b^a Agricultural Engineering Research Institute, Agricultural Research, Education and Extension Organization (AREEO), Karaj, Iran^b Seed and Plant Improvement Research Department, Kerman Agricultural and Natural Resources Research and Education Centre, Agricultural Research, Education and Extension Organization (AREEO), Kerman, Iran

ABSTRACT

In the present study, the seeds of two date palm (*Phoenix dactylifera* L.) cultivars, Mazafati and Kalutah, were analyzed for their physical properties and chemical composition. Studies were also conducted on properties of oil extracted from the seeds and its fatty acid composition. The seeds constituted about 6-10% of the fruit weight. They, on the average, contained 4.84% protein, 12.22% fat, 27.58% fiber, 80.76% carbohydrates, 1.18% ash and 1.72% moisture. Mineral analysis showed higher concentration of Fe followed by Ca, Cu, Na, Zn and Mn. The seeds were also a rich source of phenolics, which ranged from 1840.93 to 1952.93 mg GAE/100 g. The average chemical characteristics of the date seed oils were: iodine value 55.153, saponification value 228.067 and peroxide value 15.537. The main fatty acids of the seed oils were oleic (48.10-50.50%), lauric (14.00-15.80%), palmitic (10.80-11.70%), myristic (10.60-10.90%), linoleic (7.70-8.20%) and stearic acids (3.00-3.40%).

Keywords: Date seed, Date seed oil, Fatty acid composition, Kalutah date, Mazafati date

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1. Introduction

The date palm (*Phoenix dactylifera* L.) grows in the arid and semi-arid regions of the world especially in most of the Middle Eastern countries. It has played an effective role in survival of many old civilizations. As a valuable nutrient, the date palm dated back to 6000 BC. Dates have also an important role in economics of the date producing countries (Gurevich et al., 2005). Iran is one of the main date producing countries with the annual production of about 1 million tons of date and 100000-150000 tons exportation date fruit composed of a seed with a hard endocarp and a thin epicarp which constitutes 10-46% of date fruit weight (Sotolu et al., 2011). The seeds are oblong with an abdominal groove, a small embryo and a hard endosperm placed inside a cellulose wall (Al-Farsi & Lee, 2011). Date seeds are odorless with a dark brown color and bitter taste (Hamada et al., 2002). Recent studies show that date seed contains 77.52% carbohydrate (Besbes et al., 2004; Nehdi et al., 2010; Rahman et al. 2007; Sawaya et al. 1984), 5.77% protein and 10.62% fat (Besbes et al., 2009; Hamada et al., 2002; Nehdi et al., 2010; Rahman et al., 2007; Saafi et al., 2008; Sawaya et al., 1984), 9.375% moisture (Hamada et al., 2002; Nehdi et al., 2010) and 1.294% ash (Besbes et al., 2004). Many minerals such as sodium, potassium, calcium, iron, copper, magnesium, zinc, phosphorus, lead, cadmium and chromium are reported in date seeds (Abdul Afigh

et al., 2013). Date seeds are an excellent source of dietary fiber (64.5-80.15 g/100 g fresh weight) (Al-Farsi & Lee, 2011) and also rich in phenolic compounds (3102-4430 mg GAE/100 g) and antioxidants (580-929 μmol trolox equivalents/g fresh weight) (Al-Farsi et al., 2007). The oil of date seed contains high percentage of oleic and lauric acids. Natural antioxidants such as tocopherol and polyphenols are found in date seed oil. The oil has high oxidative stability due to low content of polyunsaturated fatty acids (Amany et al., 2012). Kerman is the widest province in Iran and it is in the first rank for producing date in the country. Different date varieties are cultivated in this region which among them Mazafati date and Kalutah date are considered the main cultivars and they are popular for their high quality. Mazafati date is the best date for export and domestic market. To best of our knowledge, no work has been carried out on the physicochemical properties of the seed and seed oil in these cultivars. The aim of this research was to study physicochemical properties and fatty acid profile of date seeds from two important date cultivars, Mazafati and Kalutah, grown in Kerman, Iran.

2. Material and Methods

Date cultivars, Mazafati and Kalutah, were obtained from the Agricultural Research Stations located in Bam and Jiroft regions of

*Corresponding author.

E-mail address: golshan_ta@yahoo.com (A. Golshan Tafti).

Kerman, Iran. The seeds were separated manually and soaked in water and washed to remove any adhering date flesh and then air-dried. They were further dried in oven at 60°C. The seeds were ground in a hammer mill to 1 mm particle size. The seed powders were stored under refrigeration in polyethylene bags until analysis.

2.1. Physical measurements of date seed

Twenty date fruits from each variety were selected randomly. The weight of the fruits and seeds was determined and the percentage of the seeds was calculated. The length and diameter of the date seeds were measured using a micrometer and the volume was determined by water displacement (Habib & Ibrahim, 2009).

2.2. Chemical analysis of date seed powder

Chemical analysis was performed according to the Association of Official Analytical Chemists (AOAC, 1990). Date seed oil was extracted using n-hexane solvent. Moisture content and protein content were determined by air oven and the Kjeldahl method, respectively. Protein was calculated by multiplying the total nitrogen content by a factor of 6.25 (El-Shurafa et al., 1982). To determine ash, about 2 g of date seed powder was ignited and incinerated in a furnace at 550°C for 8 h (Besbes et al. 2004). It was expressed as a percent of dry weight. The minerals (Ca, Na, K, Fe, Cu, Mn and Zn) were analyzed using an atomic absorption (Thermo Elementar AA, England). Phosphorus content was determined by the phosphomolybdo vanate method. Carbohydrate content was calculated in accordance to the following formula: 100 - (%moisture + %ash + %protein + %oil) (Nehdi et al., 2010). Total phenolics were measured by colorimetric method using Folin-Ciocateau reagent (Velioglu et al., 1998). 1,1-Diphenyl-2-Picryl-hydrazyl (DPPH) was used to determine antioxidants (Tadhani et al., 2007).

2.3. Physical and chemical analysis of date seed oil

The refractive index of date seed oil was measured using a refractometer (Atago, Japan). The iodine and saponification values were determined according to the American Oil Chemists Society method (AOCS, 1993). Peroxide value was measured in accordance to thiocyanate method.

2.4. Fatty acid composition

Fatty acids of date seed oil were determined by the preparation of fatty acid methyl esters and use of a GC-FID equipped with a capillary column (BPX70, 10 m, 0.1 mm film thickness) The detector temperature was 280°C and the column temperature was set on 50-250°C. The run time was 45 min. The fatty acid methyl esters peaks were recognized comparing their retention times with standard FAMES.

2.5. Statistical analysis

All tests were performed in triplicate. Statistical analysis was carried out using SAS software (version 9.1). Data were analyzed using a completely randomized block design test. Data were compared using analyses of variance and by the Duncan multiple range test with a probability of $p < 0.05$.

3. Results and Discussion

3.1. Physical characteristics of date seeds

Table 1 presents the average physical characteristics of date seed of the studied cultivars. Date seeds from Mazafati and Kalutah cultivars included about 6-10% of the fruit weight. The seed weight of date cultivars was in the range of 0.73-0.84 g. The average length and diameter values for the seeds were 19.40-21.05 mm and 7.38-8.37 mm, respectively. However, there were differences in physical properties among the date seeds. According to Habib and Ibrahim (2009), environmental factors, irrigation, soil fertilization and post-harvest treatments can affect the physical properties of date fruits and also likely those of date seeds.

3.2. Chemical composition of date seeds

Date seeds from Mazafati and Kalutah cultivars contained 26.18-28.56% crude fiber, 10.66-14% fat, 4.44-5.07% protein, 1.66-2.33% moisture, 1-1.52% ash and 79.32-82.97% total carbohydrate (Table 2). Kalutah date seeds had the lowest fat content (10.66%), whereas Jiroft Mazafati had the highest fat content (14%). The amount of fat in date seeds was reported in the range of 7.7 to 12.7% (Al-Farsi & Lee, 2007; Al-Shahib & Marshall, 2003; Hamada et al., 2002). The seeds of Jiroft Mazafati and Kalutah date cultivars were significantly ($p < 0.05$) higher in crude fiber (28%) and protein (5%) compared to Bam Mazafati date seeds. As a result, there were differences in chemical composition of seeds between two date cultivars (Mazafati & Kalutah) and also the cultivar grown in different regions (Jiroft & Bam). It was reported that the dietary fiber content of seeds of the 18 date varieties grown in the United Arab Emirates was different. The observed differences were probably due to maturation stage (Habib & Ibrahim, 2009). In general, our results were in agreement with those reported by Besbes et al. (2004) and Hamada et al. (2002). Saafi et al. (2008) stated that the differences in chemical composition of the flesh and seed might be due to the variability of the varieties and also climatic conditions. However, carbohydrates and fats are more important than proteins in date seeds because the protein content in date seeds is low and it may not be very digestible (Hamada et al., 2002). Table 2 shows the mineral content of date seeds for the cultivars. The seeds contained significant level of minerals such as iron, calcium, copper, sodium, zinc and manganese. Mineral analysis showed that iron concentration was the highest in both seeds.

Phosphorus and potassium were present in the lowest level, ranging from 0.06-0.08 meq/L and 0.40-0.60 meq/L, respectively. Attalla and Harraz (1996) reported that the seeds of 11 date varieties grown in Qassim region had 0.19-0.26% phosphorus. Sodium, calcium and copper contents in Mazafati date seeds grown in different regions were similar.

The level of zinc in Mazafati date seeds was in the range of 6.23-11 meq/L and it had the highest content (15.33 meq/L) in Kalutah date seeds. Minerals are important for the body. For example, iron is an essential trace element for all living organisms. Zinc participates in the structure of brain enzymes and it is essential for general growth of all tissues and also it ensures immune system of the body (Krebs, 2000; Polysangam et al., 1997). Potassium, phosphorus, magnesium, calcium and sodium had the highest levels in date seeds and Iron, manganese, zinc and copper contained the highest levels among the microelements (Ali-Mohamed & Khamis, 2004).

Table 1. Physical characteristics of date seeds of Mazafati and Kalutah grown in Kerman, Iran.

Cultivar	Physical characteristic				Percentage from fruit
	Mass (g)	Length (mm)	Diameter (mm)	Volume (ml)	
Mazafati Bam	0.84 ^a	21.05 ^a	8.37 ^a	0.62 ^a	6.23
Mazafati Jiroft	0.78 ^b	20.82 ^a	8.58 ^a	0.58 ^a	6.69
Kalutah	0.73 ^c	19.40 ^b	7.38 ^b	0.57 ^a	9.80

Means with similar letters within the same columns are not significantly different ($p < 0.05$).

Table 2. Chemical composition and mineral content of the date seeds.

Component	Cultivar		
	Mazafati Bam	Mazafati Jiroft	Kalutah
	Composition (%)		
Moisture	2.33 ^a	1.66 ^a	1.66 ^a
Fat	12 ^a	14 ^a	10.66 ^a
Protein	4.44 ^b	5.01 ^a	5.07 ^a
Ash	1.52 ^a	1.00 ^b	1.01 ^b
Total Carbohydrate	79.32 ^c	79.97 ^b	82.97 ^a
Crude Fiber	26.18 ^b	28.07 ^a	28.56 ^a
	Minerals (meq/L)		
Sodium	25.33 ^b	25 ^b	29.667 ^a
Calcium	25.33 ^b	25 ^b	29.66 ^a
Potassium	0.6 ^a	0.4 ^a	0.47 ^a
Manganese	4.5 ^b	7.6 ^a	7.9 ^a
Phosphorus	0.06 ^b	0.08 ^a	0.06 ^b
Copper	25.32 ^b	25.14 ^b	29.64 ^a
Zinc	6.23 ^c	11.0 ^b	153.33 ^a
Iron	43.76 ^b	106.66 ^a	42.90 ^c

Means with similar letters within the same rows are not significantly different ($p < 0.05$).

Sawaya et al. (1984) stated that potassium was the most abundant mineral in the seeds of Ruzeiz and Sifri date varieties, whereas sodium had the lowest concentration. According to Ali-Mohamed and Khamis (2004), total content of minerals in date seeds is comparable to minerals in barley. However, there are differences in the contents of minerals and also their order among different date seeds. These variations may be due to differences in date varieties (Sawaya et al., 1984), genetic and environmental factors, fertilizer, irrigation water and etc. (Habib & Ibrahim, 2009).

3.3. Antioxidant activity and total phenolic contents

Total phenolic contents and antioxidant activity of the date seeds are shown in Fig. 1. The date seeds had considerable antioxidant activity ranging from 194488 mM AsA/100 g to 248166 mM AsA/100 g. There were significant differences ($p < 0.05$) in total phenolic contents among the studied date seeds. On average, total phenolic contents in Mazafati date seeds (Bam & Jiroft) were 1870 mg GAE/100 g. Kalutah cultivar had the highest phenolic content (1952.93 mg GAE/100 g). However, the phenolic contents and antioxidant activity differed according to the cultivar. The phenolic contents and antioxidant activity of the seeds of three date varieties (Mabseeli, Um-sallah, and Shahal) from Oman were 3102-4430 mg GAE/100 g and 580-929 μ mol of Trolox equivalent/ g fresh weight, respectively (Al-Farsi et al., 2007). Abdul Afiq et al. (2013) reported that the total phenolic content in date seeds was 48.64 mg/100 g. The

amount of polyphenols and antioxidant activity in date seeds was reported to be higher than date fruit (up to 10 fold), grape seed and tea extract (Platat et al., 2013). Dates were also found to be good sources of antioxidants in comparison with figs, prunes, and raisins (Al-Farsi et al., 2007).

3.4. Physicochemical properties of date seed oil

The date seed oils were yellow in color and semi-solid. Physicochemical characteristics of the extracted oil of the date cultivars (Mazafati and Kalutah) are presented in Table 3. The refractive index of Kalutah seed oil (1.4599) was higher than that of Mazafati seed oils (1.4580-1.4588). Refractive index was reported to be 1.456 in *P. canariensis* seed oil (Nehdi et al., 2010) and 1.458 in two date palm cultivars of Sudan (Mahmoud Abdalla et al., 2012). The iodine value of Bam Mazafati, Jiroft Mazafati, and Kalutah seed oils were 46.2, 54.1 and 65.16 g I₂/100 g oil, respectively (Table 3). Besbes et al. (2004) stated that the iodine value of date seed oil was in the range of 44-61 g I₂/100 g oil and according to Abdul Afiq et al. (2013), it was 76.7 g I₂/100 g.

The seed oil of Kalutah had the highest peroxide value (16.598 mg O₂/1000 g oil) and on average, the peroxide value of Mazafati seed oil was 15 mg O₂/1000 g oil. The average saponification value of the date seed oils was 228. Our results were in agreement with those reported by Al-Farsi and Lee (2011), Devshony et al. (1992) and El-Shurfa et al. (1982).

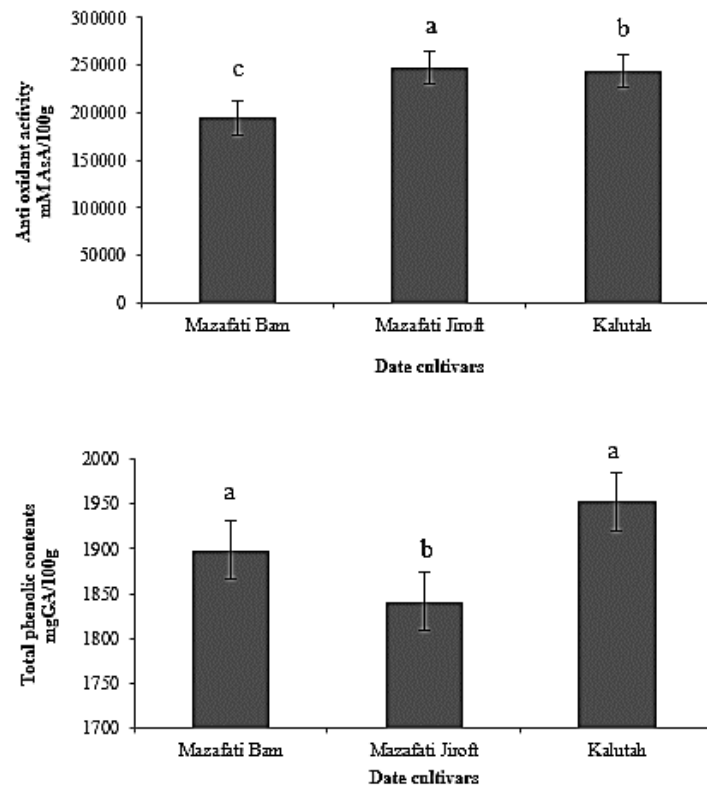


Fig. 1. Total phenolic contents and antioxidant activity of the date seeds.

Table 3. Characteristics and fatty acid composition (% of total fatty acid) of the date seed oils.

Analysis	Cultivar		
	Mazafati Bam	Mazafati Jiroft	Kalutah
Peroxide value (meq/kg)	15.36 ^b	14.65 ^c	16.59 ^a
Iodine value (gI ₂ /100g oil)	46.2 ^c	54.1 ^b	65.16 ^a
Saponification value (mgKOH/100 g oil)	227.29 ^b	171.43 ^c	285.48 ^a
Refractive index	1.4580 ^c	1.4588 ^b	1.4599 ^a
Caprylic (C8:0)	0.1	0.3	1.2
Capric (C10:0)	0.2	0.2	0.5
Lauric (C12:0)	14	14.3	15.8
Myristic (C14:0)	10.8	10.9	10.6
Palmitic (C16:0)	11.7	11.8	10.8
Palmitoleic (C16:1)	0.3	0.2	0.4
Stearic (C18:0)	3.1	3.4	3
Elaidic (C18:1) Trans	0.1	0.1	-
Oleic (C18:1) Cis	50.5	49.7	48.1
Linoleic (C18:2)	8	7.7	8.2
Linolenic (C18:3)	0.5	0.4	0.7
Gondoic (C20:1)	0.4	0.3	0.2
Behenic (C22:0)	0.1	-	-

All values given are means of three determinations.

3.5. Fatty acid composition of date seed oil

As referred, date seeds from the cultivars contained 10.66-14% fat. Table 3 presents the fatty acid composition of the date seeds, which contain saturated, monounsaturated, and polyunsaturated fatty acids. Fatty acid analysis showed that oleic acid (48.1-50.5%) and lauric acid (14-15.8%) were the main fatty acids followed by Palmitic acid (10.8-11.8%), myristic acid (10.6-10.9%), linoleic acid (7.7-8.2%) and stearic acid (3-3.4%). Therefore, date seed oil can be considered as an oleic-lauric oil. This result was in agreement with that reported by Devshony et al. (1992) and Saafi et al. (2008). Besbes et al. (2004) stated that the seed oil of some date varieties can be regarded as an oleic-linoleic oil. Behenic acid, elaidic acid, gondoic acid, linolenic acid, palmitoleic acid, caprylic acid and capric acid were minor components in the seed oils. As indicated in Table 3, fatty acid composition of Bam Mazafati seed oil is similar to that of Jiroft Mazafati. Sawaya et al. (1984) reported that oleic acid (44.25%), lauric acid (17.35%), myristic acid (11.45%), palmitic acid (10.30%) and linoleic acid (8.45%) were the major constituents in date seed oil. Al-Shahib and Marshall (2003) reported that oleic acid was the major fatty acid in the seed oil of 14 date varieties. Besbes et al. (2004) also stated that oleic, linoleic, palmitic, myristic and lauric acids together composed 92% of the total in the seed oil fatty acids of Allig and Deglet Nour dates. According to Nehdi et al. (2010), oleic acid composed about 50% of the total fatty acid in *P. canariensis* seed oil followed by linoleic acid (19.23%), lauric acid (10.24%) and palmitic acid (9.83%).

4. Conclusion

Analysis of the seeds from Iranian commercial dates (Mazafati & Klutah) showed that they contained considerable amounts of fibre, fats, protein, some minerals and total phenolics. We can conclude that the date seeds are suitable for the preparation of fibre-based foods. The results also showed that chemical composition differed among the date seeds of different varieties. The main fatty acids in both date seed oils were oleic acid and lauric acid, followed by palmitic acid, myristic acid and linoleic acid. The date seed oils were low in polyunsaturated fatty acids (8.1-8.9%). This characteristic is important in their stability during storage and they may have good shelf-life. Therefore, date seeds can be a useful source of edible oils for human consumption after testing their safety.

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