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Compositional and Sensory Characteristics of Three Native Sun-Dried Date (*Phoenix dactylifera* L.) Varieties Grown in Oman

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Three native sun-dried date varieties grown in Oman, namely, Fard, Khasab, and Khalas, were examined for their proximate composition, sugars, dietary fiber, minerals, and organic acids as well as sensory characteristics. The study was conducted on sun-dried dates due to their higher consumption compared with fresh dates. All results are expressed as mean value ± standard deveiation ($n = 3$) on a fresh weight basis except for sensory analysis. Date varieties were found to be low in fat and protein, but rich in sugars, dietary fiber, and minerals. They were found to be a good source of energy (278−301 kcal/100 g), due to the high sugar content. Total sugar content ranged from 56.1 to 62.2 g/100 g, being lowest in Khasab and highest in Khalas. Total dietary fiber content of dates varied from 6.26 to 8.44 g/100 g, of which 84−94% was insoluble fiber. Twelve minerals were studied in dates, among which the major minerals were potassium, calcium, magnesium, and phosphorus. Date varieties were also found to be an excellent source of selenium (ranging from 0.36 to 0.53 mg/100 g). Six organic acids were positively identified, among which malic acid predominated in all varieties. Differences ($p < 0.05$) in the contents of dietary fiber, organic acids, and certain minerals were observed among the three date varieties examined. Descriptive sensory analysis showed that among the nine sensory attributes studied, only the attributes color and desirability were rated as being of significantly ($p < 0.01$) higher intensity in Fard than in Khasab, whereas flesh firmness was lower ($p < 0.01$). Thus, these results suggest that although all three dates serve as a good source of vital nutrients, the Khalas variety, which is considered as premium quality, had significantly higher contents of sugar and selenium and a significantly higher energy value than the other varieties studied.

KEYWORDS: Dates; proximate composition; sugars; minerals; dietary fiber; organic acids; descriptive sensory analysis

INTRODUCTION

Dates (*Phoenix dactylifera* L.) are produced largely in the hot desert regions of the world and are marketed globally as a high-value fruit. The world production of dates has increased from ∼2.8 million tons in 1985 to ∼6.8 million tons in 2003 (*1*). The major date producers in the world are situated in the Middle East and North Africa.

Date production in Oman has greatly increased over the past two decades, and the latest estimates are at 231 000 metric tons in 2004 (*2*), contributing ∼3.4% to the total global production. This increase is also paralleled by a high consumption of dates. According to the Omani Ministry of Agriculture and Fisheries (*2*), date palm cultivation accounted for 49% of the total cultivated land and date production, representing 81% of the total fruit production. The per capita daily consumption of dates in Oman is estimated at 55−164 g (*2*), and dates are considered to be a vital component of the daily diet. In Oman, dates are consumed either fresh (30−40%) or sun-dried (60−70%). Sun-dried dates are consumed throughout the year, but their use reaches a peak during Ramadan, for breaking the fast before eating. It is, therefore, of prime importance to examine the compositional and nutritional characteristics of sun-dried dates.

Dates are rich in certain nutrients and provide a good source of rapid energy due to their high carbohydrate content (∼70−80%). Most of the carbohydrates in dates are in the form

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of fructose and glucose, which are easily absorbed by the human body (*3*−*5*). The good nutritional value of dates is also based on their dietary fiber content, which makes them suitable for the preparation of fiber-based foods and dietary supplements. Dietary fiber has important therapeutic implications for certain conditions such as diabetes, hyperlipidemia, and obesity and may exhibit a protective effect against hypertension, coronary heart disease (CHD), cholesterol, colorectal and prostate cancers, and intestinal disorders (*6*−*10*). Dates have also been reported to serve as a good source of essential minerals (*11*−*14*).

Besides nutritional value, the presence of taste-active components such as sugars and organic acids can improve the sensory characteristics of products. Thus, better taste and flavor of dates may increase their consumption. However, limited information is available regarding the compositional and nutritional characteristics of date varieties commonly grown in Oman. More detailed research on dates will enhance knowledge and appreciation for their use in a variety of food and specialty products. The objective of this research was to examine the compositional, nutritional, and sensory characteristics of three native sun-dried Omani date varieties. The health aspects of these components, where possible, are discussed.

MATERIALS AND METHODS

Date Samples. The sun-dried (commercial way of drying at 30−50 °C for 7−10 days) date varieties, namely, Fard (dark red color), Khasab (dark red color), and Khalas (dark gold color), were procured from a local farm in Fanjh, Oman, at the beginning of the 2003 harvest season. The quality standards for these dates have been well separated in Oman in accordance with their usage, sensory characteristics, and prices. Khalas is regarded as being of premium quality due to its sensory quality and high price. The sensory quality and price of Khasab are lower than those of Khalas. Thus, Khasab is perceived as being of moderate quality. Fard is known as industrial quality and mainly used for processing purposes. Sun-dried date varieties were dispatched (packed into an insulated polystyrene box with cooling gel) by TNT World Wide Express to the Food Research Center, University of Lincoln (Lincoln, U.K.). Mature fruits of uniform size, free of physical damage and injury from insects and fungal infection, were selected and used for all experiments. Upon arrival at the laboratory, the samples (100−150 g portions) were packed in polyethylene bags, sealed, and stored at −30 °C until analyzed. Sensory analyses were carried out in Oman prior to the fruits' being dispatched and frozen to −30 °C.

Chemicals. All chemicals were obtained from Sigma-Aldrich Co. Ltd. (Dorset, U.K.), unless otherwise specified.

Proximate Analysis. Percentages of moisture by vacuum oven (method 934.06), protein by Kjeldahl nitrogen (method 920.152), and ash by direct analysis (method 940.26) were determined according to the Association of Official Analytical Chemists' (AOAC) methods (*15*). The percentage of crude protein was estimated by multiplying the total nitrogen content by a factor of 6.25 (*15*). The Bligh and Dyer method (*16*) was used to determine the lipid content. Total carbohydrates were calculated by subtracting the total percent values of other measurements from 100. Proximate analyses were expressed as grams per 100 g of fresh weight. The energy value was calculated according to the method of the Ministry of Agriculture, Food, and Fisheries (MAFF) (*17*), by multiplying available carbohydrate by 3.75, protein by 4, and fat by 9. Available carbohydrates, which were used for calculation of the energy value, were calculated by subtracting the total dietary fiber from total carbohydrates.

Sugar Analysis. Sugar levels were measured according to the high-performance liquid chromatography (HPLC) method of Alasalvar et al. (*18*) with slight modifications. Sugars were extracted from dates (2 g) with 20 mL of acetonitrile/water (1:1, v/v) for 2 min. The extract was then kept in a water bath at 55−60 °C for 15 min (stirring frequently with a glass rod to aid in dissolving the sugars). It was subsequently filtered through a Whatman no. 541 filter paper. After that, another 20 mL of solvent was added to the remaining pulp, and the extraction was repeated three times. Finally, all combined supernatants were collected and made up to a final volume of 100 mL with the extraction solvent. The HPLC column, pump, refractive index detector, and autosampler used were the same as those described in a previous study (*18*). Column temperature and injection volume were set at 30 °C and 20 μL, respectively. The mobile phase (filtered through a 0.45 μm Millipore filter and degassed prior to use) was a mixture of acetonitrile and HPLC-grade water at a ratio of 75:25 (v/v) at 1 mL/min. Identified sugars were quantified on the basis of peak areas and comparison with a calibration curve obtained with the corresponding standards ranging from 1 to 10 mg/100 mL of acetonitrile/water (1:1, v/v). Sugars were expressed as grams per 100 g of fresh weight.

Mineral Analysis. Minerals in dates were determined according to the AOAC method 985.35 (*15*), using an atomic absorption (AA) spectrometer. A 5 g sample was heated over a Bunsen burner flame until most of the organic matter burned off. Then, the crucibles were left in a furnace at 525 °C for 2 days to obtain carbon-free ash. Finally, the ash obtained was dissolved in 5 mL of 1 M HNO_3 and heated over a steam bath (at 50−60 °C) for 5 min to help with dissolution. Subsequently, materials were transferred to a 100 mL volumetric flask and made up to a final volume of 100 mL with the same solvent. Minerals were determined using an Unicam 969 AA spectrometer equipped with a GF90 furnace and an FS90 furnace autosampler (Unicam Limited, Cambridge, U.K.). Minerals were quantified on the basis of peak areas and comparison with a calibration curve obtained with corresponding standards. Minerals were expressed as milligrams per 100 g of fresh weight.

Dietary Fiber Analysis. Determination of dietary fibers was carried out using the AOAC enzymatic−gravimetric official method (991.43) (*15*). First, the sample was desugared by three extractions, each with 85% ethanol (10 mL/g), and then dried overnight at 40 °C. Otherwise, the total dietary fiber content would have been overestimated. Cellulose and hemicellulose, the main constituents of insoluble dietary fiber in dates, are not soluble in ethanol. Although ethanolic extraction was able to remove some of the fiber, this was found to be insignificant as this extraction was carried out prior to enzymatic digestion of the samples. Finally, the flow diagram outlined by the AOAC procedure was followed. Contents of crude protein (percentage total nitrogen × 6.25) and ash determined by using the methods described above were used to correct the fiber content. Dietary fiber was expressed as grams per 100 g of fresh weight.

Organic Acid Analysis. Organic acids were extracted and purified according to the method of Alasalvar et al. (*18*) with slight modifications. A 20 g sample was homogenized in 100 mL of 0.1% phosphoric acid (containing 0.003% butylated hydroxyanisole; BHA) for 3 min in an ice bath. The extract was vacuum-filtered through Whatman no. 1 filter paper. The filtrate was brought to 100 mL with the extraction solvent to give the extract. Afterward, the filtrate (5 mL) was cleaned by passing through a disposable C_{18} Sep-Pack cartridge (Waters Corp., Milford, MA), previously conditioned by flushing with 2 mL of acetonitrile followed by 5 mL of HPLC-grade water. The HPLC column, pump, diode array detector, and autosampler used were the same as those described in a previous study (*18*). Column temperature and injection volume were set at 30 °C and 10 μL, respectively. The mobile phase (filtered through a 0.45 μm Millipore filter and degassed prior to use) was a 0.1% phosphoric acid at a flow rate of 0.5 mL/min. The diode array detector was set at 210 nm. Identified organic acids were quantified on the basis of peak areas and comparison with a calibration curve obtained with the corresponding standards ranging from 5 to 1000 mg/100 mL of 0.1% phosphoric acid. Organic acids were expressed as milligrams per 100 g of fresh weight.

Descriptive Sensory Analysis (DSA). DSA (*19*) was used to assess the sensory characteristics of sun-dried date varieties. Prior to DSA, the following attributes/descriptors (attractiveness, color, skin firmness, flesh firmness, sweetness, acidity, flavor, astringency, and desirability) on a 5-point scale were selected by evaluating the odor, taste, and visual appearance of five different coded sun-dried date varieties, by 10 male expert panelists (aged 25−40 years), all of whom have been dealing with different aspects of dates (horticulture, protection, and processing) for at least 5 years. Therefore, no standard attributes were needed because all panelists had the experience to distinguish the sensory

Table 1. Proximate Composition (Grams per 100 g) and Caloric Value of Sun-Dried Date Varieties[a]

component	Fard	Khasab	Khalas
carbohydrates[b]	77.13 ± 0.47c	79.32 ± 0.39c	83.41 ± 0.59d
protein	1.47 ± 0.02c	1.61 ± 0.03d	1.68 ± 0.17d
fat	1.41 ± 0.18c	0.98 ± 0.16d	0.52 ± 0.15e
moisture	18.5 ± 0.23c	16.5 ± 0.17d	12.6 ± 0.25e
ash	1.49 ± 0.04c	1.59 ± 0.03d	1.79 ± 0.02e
energy[c] (kcal/100 g)	278c	281c	301d

[a] Data are expressed as mean ± SD ($n = 3$) on a fresh weight basis. Means ± SD followed by the same letter, within a row, are not significantly different ($p > 0.05$). [b] Carbohydrates were calculated by subtracting total percent values of other measurements from 100. [c] Energy value was calculated by multiplying available carbohydrate by 3.75, protein by 4, and fat by 9. Available carbohydrates, which were used for calculation of the energy value, were calculated by subtracting the total dietary fiber from total carbohydrates.

attributes of dates. The assessment was carried out under natural daylight at ambient temperature. Dates were prepared by washing in water and allowing them to dry naturally in order to remove bloom, dust, and spray deposits. The fruits selected for each assessment were representative of the variety in size, appearance, and stage of maturity. Date samples (five fruits for each assessment) were presented randomly to each panelist for evaluation (samples were evaluated twice). Each sample was coded with a random three-digit number.

Statistical Analysis. Results were expressed as mean ± standard deviation (SD) ($n = 3$) on a fresh weight basis except for DSA. Statistical significance (*t* test: two-sample equal variance, using two-tailed distribution) was determined using the Microsoft Excel Statistical Data Analysis. Differences at $p < 0.05$ were considered to be significant.

RESULTS AND DISCUSSION

Proximate Analysis. The proximate composition and caloric value of three native Omani date varieties are summarized in **Table 1**. Carbohydrate was the predominant component in all varieties, ranging in concentration from 77.13 g/100 g (in Fard) to 83.41 g/100 g (in Khalas), followed by moisture, along with small amounts of protein, fat, and ash. Significant ($p < 0.05$) varietal differences existed in proximate composition among varieties, with some exceptions. These values were within the range of results previously published in the literature (*3*, *4*, *14*).

The energy values determined ranged from 278 kcal/100 g in Fard to 301 kcal/100 g in Khalas, due to their high carbohydrate content (mainly sugar). Similar energy values for different date varieties were reported by other researchers (*20*, *21*). The energy requirement for adult men ranges from 2300 to 2900 kcal/day and is 1900−2200 kcal/day for adult women (*22*). Hence, a typical portion of 100 g of dates supplies ∼11−15% of the total energy requirement per day for adults.

Sugar Composition. Two monosaccharides, fructose and glucose, were the only sugars detected in the three date varieties. The highest content of average total sugar was found in Khalas (62.2 g/100 g), followed by Fard (56.7 g/100 g) and Khasab (56.1 g/100 g). Both fructose and glucose were present almost at a ratio of 1:1 (**Table 2**). No significant ($p > 0.05$) differences existed in total sugar content between the Fard and Khasab varieties. The number of sugars identified and levels in this study were in agreement with those published previously (*3*, *4*, *14*). Ahmed et al. (*3*) found that the total sugar content in 12 different varieties of dates grown in the United Arab Emirates varied from 44.3 to 64.1 g/100 g. Fructose and glucose, which were also present at a ratio of 1:1, were the only sugars detected in their study.

Table 2. Sugar Composition (Grams per 100 g) of Sun-Dried Date Varieties[a]

sugar	Fard	Khasab	Khalas
fructose	28.2 ± 0.8b	27.4 ± 0.7b	31.9 ± 1.4c
glucose	28.5 ± 0.2b	28.7 ± 0.5b	30.3 ± 1.0c
fructose/glucose	0.99	0.95	1.05
total	56.7 ± 0.6b	56.1 ± 1.1b	62.2 ± 2.3c

[a] Data are expressed as mean ± SD ($n = 3$) on a fresh weight basis. Means ± SD followed by the same letter, within a row, are not significantly different ($p > 0.05$).

Table 3. Mineral Content (Milligrams per 100 g) of Sun-Dried Date Varieties and Percentage of RDA[a]

mineral	Fard	Khasab	Khalas	av, % of RDA[b]
calcium	81.9 ± 1.9c	55.0 ± 2.8d	84.7 ± 2.7c	9.2
chromium	0.01 ± 0.02c	0.01 ± 0.0c	0.01 ± 0.02c	5–20
cobalt	0.03 ± 0.01c	0.03 ± 0.02c	0.03 ± 0.01c	
copper	0.77 ± 0.03c	0.64 ± 0.03d	0.64 ± 0.03d	22.8–45.6
iron	0.60 ± 0.11c	1.09 ± 0.02d	0.58 ± 0.04c	5–7.6
manganese	0.30 ± 0.04c	0.19 ± 0.03d	0.29 ± 0.03c	5.2–13
magnesium	60.9 ± 1.2c	66.8 ± 0.2d	76.2 ± 1.1e	19.4–24.3
phosphorus	59.3 ± 1.3c	63.0 ± 2.8d	74.0 ± 1.7e	8.2
potassium	624 ± 5c	603 ± 14c	742 ± 14d	32.8
selenium	0.38 ± 0.01c	0.36 ± 0.02d	0.53 ± 0.04e	600–770
sodium	3.49 ± 0.12c	2.43 ± 0.14d	3.61 ± 0.41c	0.2–0.6
zinc	0.45 ± 0.02c	0.60 ± 0.02d	0.53 ± 0.04e	3.5–4.4

[a] Data are expressed as mean ± SD ($n = 3$) on a fresh weight basis. Means ± SD followed by the same letter, within a row, are not significantly different ($p > 0.05$). [b] Average percentage of recommended dietary allowances (RDA) for adults (*22*).

The sugars in dates are the most important constituents as they provide a rich source of energy to the human system. Reducing sugars, such as glucose, are readily absorbed during digestion and lead to rapid elevation of blood sugars (*23*). Besides their energy sources, sugars are also responsible for the sweetness of foods. As fructose is twice as sweet as glucose, it induces a feeling of satiety and may also reduce the total calorie intake compared to other foods (*24*).

Minerals. This is the first study that reports the mineral composition of these three date varieties (**Table 3**). Among the minerals studied, potassium was most abundant with a concentration of 603−742 mg/100 g, followed by calcium (55−84.7 mg/100 g), magnesium (60.9−76.2 mg/100 g), and phosphorus (59.3−74.0 mg/100 g). Dates were also found to be rich sources of iron (0.58−1.09 mg/100 g), copper (0.64−0.77 mg/100 g), and manganese (0.19−0.30 mg/100 g) and an excellent source of selenium (0.36−0.53 mg/100 g). These results are, in general, comparable with those published previously on different date varieties (*3*, *4*, *11*−*13*).

With regard to human nutritional aspects, all date varieties have significant mineral contents. Eating approximately 13.4 and 17 g of dates (from an average of three date varieties) per day supplies 100% of the recommended dietary allowances (RDA) for selenium (*22*) for adult women and men, respectively. In addition, 100 g of dates approximately provides up to 19.4−24.3% magnesium, 32.8% potassium, 5.2−13% manganese, 22.8−45.6% copper, and 5−20% chromium of the daily RDA for adults. The high potassium and low sodium contents in dates are desirable for people suffering from hypertension (*25*).

Although each mineral has its own health benefits, minerals are generally important as constituents of bones, teeth, soft

Table 4. Dietary Fiber Content (Grams per 100 g) of Sun-Dried Date Varieties[a]

fiber	Fard	Khasab	Khalas
insoluble	6.73 ± 0.14b	7.36 ± 0.23c	5.89 ± 0.07d
soluble	1.27 ± 0.12b	1.08 ± 0.12c	0.37 ± 0.02d
total	8.00 ± 0.23b	8.44 ± 0.17c	6.26 ± 0.07d

[a] Data are expressed as mean ± SD ($n = 3$) on a fresh weight basis. Means ± SD followed by the same letter, within a row, are not significantly different ($p > 0.05$).

tissues, hemoglobin, muscle, blood, and nerve cells. Minerals are also vital to overall mental and physical well-being (*17*, *26*, *27*). As mentioned above, dates were found to be an excellent source of selenium, which plays a major antioxidant role. Selenium protects cell membranes by preventing free radical generation, thereby decreasing the risk of cancer and diseases of the heart and blood vessels. Medical surveys have shown that increased selenium intake decreases the risk of breast, colon, lung, and prostate cancer and may preserve tissue elasticity (*28*−*30*).

Dietary Fiber. Table 4 presents the content of dietary fiber (insoluble, soluble, and total) in three varieties of dates. Total dietary fiber contents in Fard, Khasab, and Khalas were 8.00, 8.44, and 6.26 g/100 g, respectively. Significant differences ($p < 0.05$) existed in insoluble, soluble, and total dietary fiber contents among varieties. Insoluble and soluble fibers contributed 84−94 and 6−16% to the total dietary fiber present among varieties, respectively. Unlike this study, Myhara et al. (*5*) reported a higher content of total dietary fiber in Fard and Khalas varieties grown in Oman, in concentrations of 13 and 13.3 g/100 g of dry weight (∼11 and 11.2 g/100 g of fresh weight), respectively. These differences could be related to the stage of maturation, as during the ripening process enzymes gradually break down these substances to more soluble compounds (*31*). Recently, Al-Shahib and Marshall (*14*), who surveyed the total dietary fiber contents of 14 date varieties from various countries, found that the percentage of total dietary fiber was in the range of 6.4−11.5%, depending on variety and degree of ripeness. Slightly higher ranges of total dietary fiber contents (7.2−14.9%) in 13 prepacked date varieties from various countries were also reported by Aidoo et al. (*32*). Our results were within the range of their findings.

The dietary fiber contents of a number of fresh fruits, namely, apples, apricots, berries, grapes, oranges, peaches, and plums, were reported by Marlett et al. (*33*) using the Prosky method. The values obtained ranged from 1.0 g/100 g for grapes to 4.4 g/100 g for raspberries. In addition, the contents of dietary fiber, obtained by using the Prosky method, in dried apricots, prunes, figs, and raisins were 7.7, 8.0, 12.2, and 5.1 g/100 g, respectively (*33*−*35*). Thus, dates serve as a good source of fiber compared with other fresh and most dried fruits.

Although no RDA has been set, most health/nutrition professionals agree on the benefits of increased consumption of dietary fiber to 25−35 g/day (*36*, *37*). Eating ∼330−460 g of dates per day is adequate for this requirement. Dietary fiber (indigestible carbohydrate) is not a nutrient, but it still plays a very important role in maintaining good health (*6*−*8*). Soluble fiber dissolves in the gut to form a viscous gel that slows the release of some nutrients, particularly glucose, into the bloodstream. Blood cholesterol is a major risk factor for CHD, and increasing consumption of dietary fiber has been recommended as a means to lower cholesterol levels. It has been suggested that soluble fiber reduces total and low-density lipoprotein (LDL) cholesterol. One gram of soluble fiber from oat products has been reported to decrease total cholesterol by 0.045 mmol/L and LDL cholesterol by 0.057 mmol/L (*9*). In addition, many studies have found that high-fiber diets, especially those high in soluble fiber, can reduce the risk of prostate cancer (*10*).

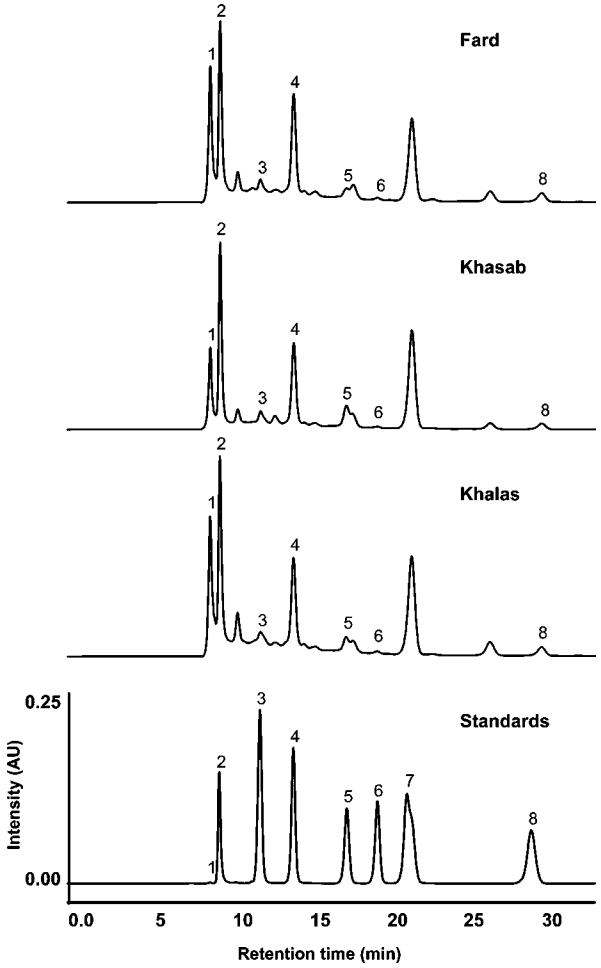

Figure 1. Comparison of organic acids chromatographs of sun-dried date varieties and standards. Peaks: mobile phase (1), oxalic acid (2), citric acid (3), malic acid (4), succinic acid (5), formic acid (6), acetic acid (7), and isobutyric acid (8).

The high content of insoluble fiber is of benefit in weight control and the health of the large intestine. It is present in high levels in dates and has a spongelike effect in the gut, soaking up water and swelling in size. This effect produces a feeling of fullness and adds bulk to the gut contents, increasing the mass frame waste matter and speeding it through the large intestine, thus reducing the risk of constipation and possibly even cancers of the digestive system (*38*−*40*).

Organic Acid. Figure 1 illustrates a typical chromatographic separation of organic acids extracted from three date varieties in comparison with standards. The average contents of total organic acids in dates of Fard, Khasab, and Khalas varieties were 2656, 1941, and 2453 mg/100 g, respectively (**Table 5**). Differences ($p < 0.05$) in total content of organic acids were observed among date varieties. Six organic acids were positively identified, among which malic acid was the predominant organic acid, and its concentration ranged from 1265 to 1396 mg/100 g, followed by lesser amounts of succinic acid, isobutyric acid, citric acid, oxalic acid, and formic acid. Malic acid itself contributed 52.2−65.2% to the total organic acid content of date varieties tested. Some peaks remained unidentified (**Figure 1**).

Table 5. Organic Acid Composition (Milligrams per 100 g) of Sun-Dried Date Varieties[a]

acid	Fard	Khasab	Khalas
oxalic	140 ± 8b	101 ± 6c	134 ± 5d
citric	197 ± 5b	125 ± 8c	215 ± 20d
malic	1386 ± 37b	1265 ± 31c	1396 ± 36b
succinic	702 ± 45b	196 ± 20c	410 ± 32d
formic	19.5 ± 0.2b	19.8 ± 0.1b	28 ± 2.8c
isobutyric	212 ± 8b	234 ± 6c	270 ± 17d
total	2656 ± 21b	1941 ± 12c	2453 ± 19d

[a] Data are expressed as mean ± SD ($n = 3$) on a fresh weight basis. Means ± SD followed by the same letter, within a row, are not significantly different ($p > 0.05$).

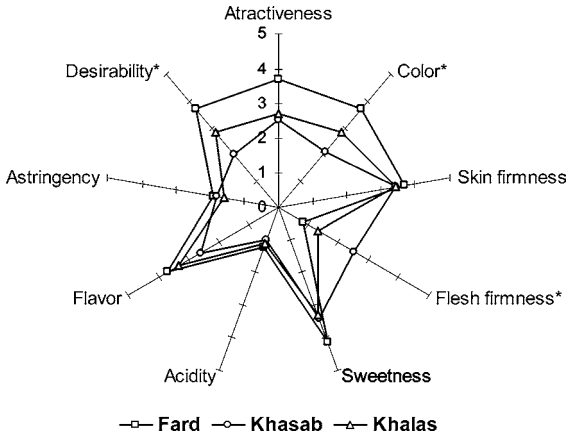

Figure 2. DSA of sensory attributes in sun-dried date varieties (scaling: 0 = none, 5 = very). Statistical significance: * ($p < 0.01$), only between the varieties of Fard and Khasab.

The contents of organic acids of date varieties were somewhat higher than those reported for different Egyptian date varieties (*41*). Youssef et al. (*41*) found that the total acidity varied from 0.1 to 0.2% when expressed as malic acid equivalents. The observed differences may be due to either cultivation condition or soil type or method used for analysis. However, the values obtained in this study (ranging from 1.9 to 2.7%) are comparable to the total amount of organic acid in fruits, as they vary from about 0.7% in strawberry (*42*) to 4% in black currant (*43*).

Organic acids are intermediates of metabolic processes in dates. These acids are directly involved in growth, maturation, and senescence. Organic acids also influence the growth of microorganisms in fruit and therefore affect the keeping quality of the product. Another aspect of organic acids is their influence on the sensory properties of dates as they are responsible for sour, tart, acidic, and characteristic fruity tastes of many foods (*44*, *45*). Malic acid, the predominant organic acids in dates, has a characteristic fruity, mellow, smooth, tart, and sour taste in fresh fruits and vegetables. The presence and composition of organic acids may be affected by various factors such as variety, growing condition, maturity, season, geographic origin, fertilization, soil type, storage conditions, amount of sunlight received, and time of harvest, among others (*3*, *41*).

DSA. Because of genetic differences, growing conditions, and amount of sunlight received some date varieties showed variations in their sensory attributes (**Figure 2**). Prior to sun-drying, both Fard and Khasab varieties were in red, which turned dark red after sun-drying due to browning reactions (enzymatic and nonenzymatic). However, Khalas turned from yellow to dark gold.

Intensities for nine sensory attributes (attractiveness, color, skin firmness, flesh firmness, sweetness, acidity, flavor, astringency, and desirability) were assessed, among which only color and desirability were rated as being of significantly ($p < 0.01$) higher intensity in Fard than in Khasab, whereas that of flesh firmness was lower ($p < 0.01$). Contributions of acidity and astringency notes were generally low among varieties, and no significant differences ($p > 0.05$) were observed. The commercial quality of dates increases with lower acidity and astringency (*46*, *47*).

The data presented in this study show that all sun-dried date varieties may be considered as a nutritious food and can play a major role in human nutrition and health because of their wide range of nutritional components. Thus, these nutritional attributes demonstrate that dates can serve as an important healthy food in the human diet. Among the date varieties studied, the Khalas variety, which is considered to be of premium quality, had significantly higher contents of sugar and selenium and a significantly higher energy value than the other varieties studied. The results of this study partially support this classification as well as providing compositional and nutritional information about Omani dates. The contents and composition of sugars and organic acids may also play a major role in the taste and flavor of date varieties. The reason we did not calculate the results on a dry weight basis to overcome the differences in moisture content among varieties was that we thought that fresh weight calculation was more appropriate from a consumption viewpoint, and this clearly represents the nutritional benefits of these fruits. Further research is needed to compare the fresh and sun-dried date varieties (on both fresh and dried weight bases) in terms of their compositional and nutritional characteristics.

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