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Phytochemical Phytochemical Properties of Fully Ripe Date Powder of Selective Omani Date (Barni, Fard, Khalas and Madloki) Cultivars

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ABSTRACT

Dates are an excellent source of polyphenols which makes them a valuable avenue for pharmacological properties. However, there are underutilized date fruits in Oman. In this study, four commonly grown Omani date cultivars, namely Barni, Fard, Khalas and Madloki at Tamar stages, were investigated for their total phenolic contents, phenolic and flavonoid compounds, vitamin C, *β*-carotene, tannins and saponins. The acidic-aqueous and alcoholic extracts were obtained from the dried powder of date varieties. Total phenolic contents were determined spectrophotometrically by using Folin-Ciocalteu reagent. Phenolic acids, flavonoids, *β*-carotene and vitamin C, were determined using high-performance liquid chromatography. Tannins and saponins were analyzed qualitatively. The results showed that there were differences among date cultivars in terms of total phenolic and flavonoids compounds. Madloki date powder exhibited the highest concentration of vitamin C and total phenolic compounds. Fard date powder had the highest concentration of flavonoid compounds, though it showed a lower concentration of *β*-carotene. A comparatively higher concentration of quercetin was observed in Madloki dates. The study results provide evidence that the investigated Omani date fruits possess potential nutraceutical properties.

Keywords: Omani Date Cultivars; Phytochemical Properties; *β*-carotene; Vitamin C

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1. Introduction

Plants contain various chemical compounds such as sugars, proteins, minerals, vitamins, and phytochemicals that serve as natural antioxidants. Natural antioxidants are widely explored for their ability to protect human cells from oxidative stress damage (Silva *et al*., 2007). The fruits of the date palm are an important component of the diet and are commonly consumed in different countries around the world (Besbes *et al*., 2004). Date palm fruits are rich in natural antioxidants (polyphenols and flavonoids) that provide a protective effect in the cell against oxidative stress caused by free radicals, atmospheric pollutants, ultraviolet rays, toxic chemicals, cigarette smoking, oxidizing agents, and carcinogenic effectors (Devasagayam *et al*., 2004; Waly *et al*., 2015).

More than 300 date fruit varieties are successfully grown in the Sultanate of Oman (Al-Yahyai, 2012). It was reported that Oman produced 255,871 metric tons of date fruit in 2010, which is 3.7% of global date production (Al-Yahyai, 2012). It was increased to 328,392 metric tons in 2014, which positioned Oman in eighth place among the top date producing countries in the world. Date fruit is highly consumed in Oman; the daily consumption of dates per person in Oman is approximately 55-164 g (Al-Harrasi *et al*., 2014). date fruits are consumed at all levels of maturation, including *Khalal* or *Besser* (the mature but unripe with 50% moisture), Rutab (ripened with 30%–35% moisture), and *Tamar* (mature with 10%–30% moisture) (Al-Shwyeh *et al*., 2019). Date fruit possesses different medicinal properties, including anticancer, gastroprotective, antihyperlipidemic, hepatoprotective, and nephroprotective activities (Waly *et al*., 2015). Phenolic compounds are the main contributor to the antioxidant effect in date fruit and contribute to the functional properties and health benefits of dates (Khalid *et al*., 2017).

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In addition, there are many compounds in date fruits that contribute to antioxidant activity, including; vitamin C and Saponins, which protect against oxidative stress (Iqbal *et al*., 2014 & Gemede *et al*., 2014). Dates are reservoirs of all antioxidants like tocopherols, ascorbate, and carotenoids; therefore, their demand as nutraceuticals is rising day by day (Nasir *et al*., 2015). Despite that, there are underutilized date fruits in Oman which used for animal feeds in the camel, sheep, cattle and poultry industries (Rahman *et al*., 2007). This study will evaluate the phytochemical properties of four (Barni, Fard, Khalas and Madloki) Omani date powders. The results of this study will provide evidence that the assayed Omani date fruits possess potential nutraceutical properties. Therefore, dates will be applicable in the food industry for the preparation of functional and nutraceutical ingredients from Omani date fruits. This study will help in developing strategies for functional food development at an industrial scale for underutilized date fruits in Oman.

2. Material and Methods

2.1. *Preparation of Date Powder*

Dates fruits were taken to the Department of Food Science and Nutrition lab for further processing and analysis. Date powder was prepared to refer to the method suggested by Shyma *et al*., 2008: a uniform size of palm date fruits was used in all the experiments. Dates were cut into small species, spread on a plate and subjected to drying in an oven drying at 60°C for 24 h. After 24 hours, the temperature was readjusted to 80°C, and drying continued for another 24 h. Then dried dates were ground, and date powder was obtained and kept in the airtight jars for further use (Fig. 1).

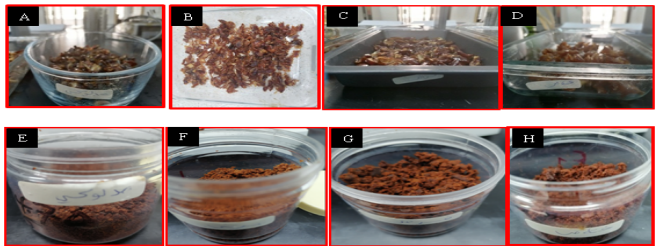

Fig. 1. Dates Fruit before Drying and Date's Powder after Drying and Grinding. Dates fruit before drying (Madloki, Barni, Fard, Khalas A, B, C, D respectively). Date's powder (Madloki Barni, Fard, Khalas E, F, G, H respectively).

2.2. *Extract Preparation*

Dried date powder (1.5 g) of each sample was mixed with to 50 mL extraction solvent (70 mL methanol: 29.5 mL distilled water: 0.5 mL Hydrochloric acid; Volume/Volume/Volume ratio) in a conical flask and placed in an ultrasonic machine, and after 2 cycles of 30 minutes, the extract was filtered and placed into an ultrasonic water bath for 30 min. The solvent was removed using a rotary evaporator at 50 °C and 175 mbar for one and half hours. The dried extract was then placed in an amber glass, covered with aluminum foil, and stored in a refrigerator until further analysis (Lembe *et al*., 2015).

2.3. *Determination of Total Phenolic Contents*

Total phenolic contents were spectrophotometrically determined by using Folin-Ciocalteu (FC) method. Different concentrations of date powder extract (20, 50, and 100 ppm) were prepared in test tubes and mixed with the FC reagent (1500 µL, 10% v / v), and stirred for 1 min.

After stirring, 1500 µL 10% w/v, sodium carbonate (Na_2CO_3) solution was added to the mixture. Test tubes containing date extract samples and reagents were vortexed and kept in the dark for 90 min to complete the reaction. The absorbance was measured at 725 nm (Thermo Scientific Genesys G-10S UV-VIS Spectrophotometer) to determine the total phenolic contents. Gallic acid was used as a standard to construct the calibration curve. The total phenolic content was expressed as mg of Gallic acid equivalents (GAE) per 100 g of dried date extract.

2.4. *Analysis of Phenolic Compounds and Flavonoids by HPLC*

Phenolic acids and flavonoids in each date powder were measured according to the method previously described by Eimad *et al*. (2018) with some modifications. Precisely 20 µL date powder extract was injected in a Teknokroma C18 column (15 cm x 0.3 cm, 3 µm particle size) thermoset at 28 °C. The mobile phase was composed of: (eluent A) 0.1% acetic acid in the water and (eluent B) 500 mL acetonitrile. The gradient system was used as: 0–0.1 min, 0–2% solution B, 0.1–27 min, 2–25% solution B, 27– 28 min, 25-40% solution B, 28–33 min, 40–40% solution B, 33-35 min, 44-44%, 35-43 min, 44-10% solution B, 43-44min, 10-10% solution B. Elution was performed at a flow rate of 0.3 mL/min. The wavelength for the detection of phenolic acids and flavonoids were set at 280 nm. Standards of 10 phenolic acids (Gallic acid, 3,4-dihyroxybenzoic acid, Chlorogenic acid, Vanillic acid, Caffieic acid, Syringic acid, *P*-coumaric acid, Ferulic acid, Cinnamic acid, 2-hydroxycinnamic acid) (from sigma-Aldrich) and three flavonoids (Rutin hydrate, Quercecin, Keampferol) (from Sigma-Aldrich) were prepared in methanol at a concentration of 100 mg/mL (Al Harthi *et al*., 2015). The phenolic acids were quantified by comparing the area of the peaks detected at 280 nm with the corresponding area for commercial standards of each acid. The results were expressed in mg/g on a dry basis.

2.5. *Quantification of β-carotene in Date Powder by HPLC*

Exactly 500 mg of dried date powder were extracted with 15 mL of petroleum ether with constant stirring by homogenizer (Ultra Turrx) until colorless extracts were obtained. Then, suspensions were filtered and concentrated in a stream of nitrogen up to 1.0 mL. Beta-carotene was determined by SPD-M20A Prominence, a diode array detector (HPLC-DAD) (M.Nauman Ahamad *et al*., 2007). Twenty microliters of each extract were injected in a Bondapak C18 column (300 x 3.9 mm, 10 µm particle size), Isocratic system. The mobile phase was 70 mL acetonitrile, 20 mL dichloromethane and 10 mL methanol, the flow rate was 2 mL/min, and the wavelength was 452 nm. The standard was prepared by taking 10 mg *β*-Carotene standard in 100 ml n-hexane (100 ppm), then diluted to different concentrations (20,40,60, and 80 ppm). The *β*-carotene standard curve was detected at the retention time of 1.5 min, and the yielded standard curve was used to determine the quantities.

2.6. *Determination of Vitamin C in Date Powder by HPLC*

Fifteen grams of metaphosphoric acid were dissolved in 450 mL distilled water and 40 mL glacial acetic acid. The date samples (0.4 g) were added to 2 mL of the prepared solution. After that, it was kept in a 5 mL volumetric flask and then diluted up to the mark and filtered using a 0.45 µm pore filter (Kapur *et al*., 2012). Vitamin C was determined by the HPLC-DAD method. The mobile phase was prepared using 1% acetic acid in isocratic mode, 20 µL was injected into HPLC, and the flow rate was set at 0.7 mL/min. The optimal wavelength used to determine vitamin C was 245 nm. 0.1 g of L-ascorbic acid was dissolved in 100 mL of 1% acetic acid. The stock solution was used to prepare serial concentrations (20, 40, 60, and 80 ppm) to establish the calibration curve. A calibration curve was used to determine the quantities.

2.7. *Qualitative Analysis of Tannins*

A qualitative analysis of tannins was done according to Aisha et al. (2015). Date powder, 0.1g, was kept in a test tube, and then 3.0 ml of butanol-HCl reagent (95 mL of n-butanol and 5.0 mL concentrated HCl) was added to it. The test tubes were heated in a water bath for one hour. The appearance of pink color was a sign of the presence of tannin qualitatively.

2.8. *Qualitative Analysis of Saponins*

A qualitative analysis of saponins was done according to Aisha *et al.,* (2015) 0.5 g of date powder was extracted in 5.0 mL of a 50% aqueous methanol solution, and then the extract was transferred into a test tube and shaken vigorously. The formation of persistent foam on the surface was considered an indication of the presence of saponins.

2.9. *Statistical Analysis*

GraphPad Prism software (version 5) was employed for the statistical analysis. All the results were expressed as mean ± standard deviation (SD). The data were analysed using one-way ANOVA, followed by Tukey's multiple comparison test and unpaired *t*-test. The differences were considered statistically significant when *P* value < 0.05.

3. Results and Discussion

3.1. Analysis of Total Phenolic Contents in Date Powder

Total phenolic content in date powder ranged from 771.36 to 994.24 mg GAE/100 g dry weight of date powder. The Madloki date powder showed the highest amount of total phenolics with 994.24 mg GAE /100 g of dry weight sample, which was expected due to the intense dark red color of Madloki dates extract. The Khalas dates had 918.31, and the Fard had 785.59 mg of GAE /100g dry weight. The lowest concentration of total phenolics was recorded in Barni dates (771.36 mg of GAE /100g of dry weight sample) (Fig. 2). In contrast to our observation, Al Farsi *et al*., 2005, found a lesser concentration of total phenolics in three Omani date cultivars (Fard, Khalas, Khasab). The concentrations were reported as 217 to 343 mg of GAE /100 g. The variability in total phenolic content in fruits is influenced by multiple factors, including growing condition, variety, maturity, fertilizer, season, soil type, geographic origin, the amount of sunlight received and the storage conditions (Al Farsi *et al*., 2005). Besides, the drying method, extraction solvent and extraction method also affect the total phenolic contents.

Generally, drying induces oxidative decomposition either enzymatically by thermal degradation or by polyphenol oxidase and glycosidase of phenolic compounds (Shahidi and Naczk, 2004). Due to its high polyphenol content, date powder is considered superior to fresh and dried dates. Similarly, the Total Phenolic Content of three Omani date varieties (Khasab, Fardh, Khalas) at Rutab stages is 8 to 178 mg GAE /100 gm of dry weight, and at the Tamar stages ranged from 194 to 234 mg GAE /100 gm of dry weight (Singh *et al*., 2012).

One recent study reported a lesser amount of total phenolics (32.24 to 35.84 mg/100g Caffeic acid equivalent) in four Omani dates (Bunarinja, Khasab, Fardh, Khalas) collected from Al-Dakhilya and Al-Sharqiya region (Al Harthi,2015).

In dates from Saudi Arabia (Khesab, Sukkary, Ajwa), the total phenolic content is 55.2 to 57.8 mg of GAE/30 g fresh weight (Nassar *et al*., 2016). In contrast, in Algerian dates, it ranged from 226 to 955 mg GAE/100 g fresh weight (167 to 709 mg GAE/100 g of fresh weight), expressed as Gallic acid equivalents (Benmeddour *et al*., 2013). In six Tunisian date cultivars, the total phenolic contents ranged from 199.43 to 576.48 mg GAE /100 g fresh weight (Kchaou *et al*., 2013). In another study of seven ripe Algerian dates, the phenolic profiles were in the range of 2.49 to 8.36 mg GAE /100 g of fresh weight (Mansouri *et al*., 2005). The findings of the present study reflect that of Al-Yahyai *et al*. (2015) in total phenolic content in Fardh date powder in a pilot-scale Spray Dryer produced at various processing conditions (150 ºC -170 ºC) ranging from 130.9 to 1134.9 mg GAE /100 g dry weight. The reasons for the differences in the total phenolic contents of the four different date cultivars might be attributed to their differences in carbohydrate content and genetics, as well as variation in soil cultivation. Due to the high total phenol content, dates, particularly Madloki date powder, have a commercial value and can be employed in the industrial and medicinal industries, *P* <0.05.

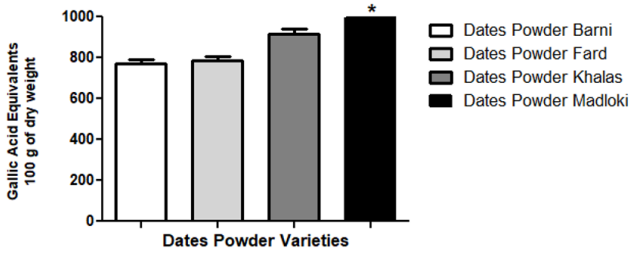

Fig. 2. Total Phenols in Powder of Four (Barni, Fard, Khalas and Madloki) Date Cultivars. *Significantly higher than other date varieties, P < 0.05.

3.2. Analysis of Phenolic Acids by HPLC

Gallic acid was the first compound shown in the HPLC chromatogram at a retention time of 3.925 min, followed by 3,4-dihydroxybenzoic acid at 10.939 min, chlorogenic acid at 18.387 min, vanillic acid at 20.177 min, caffeic acid at 20.956 min, syringic acid at 21.472 min, *P*- coumaric acid at 26.535 min, ferulic acid at 28.574 min, O-coumaric acid at 33.04 min and cinnamic acid at

36.669 min (Table 1, Fig. 3). Gallic acid was the most abundant phenolic acid in all dates cultivars (Barni, Khalas, Fard, Madloki). Khalas date powder had the highest concentration of gallic acid compound, about 19.61mg/g dried weight sample, while Fard and Madloki date powder was 12.40 and 11.33 mg/g. Barni dates were found to be the lowest in gallic acid concentration (9.27 mg/g). Barni date powder was also found to be lowest in 3,4-dihydroxybenzoic acid (0.82 mg/g), while Madloki date powder had the highest concentration of 3,4-dihydroxybenzoic acid (1.97 mg/g), followed by Fard (1.24 mg/g). and Khalas (0.99 mg/g).

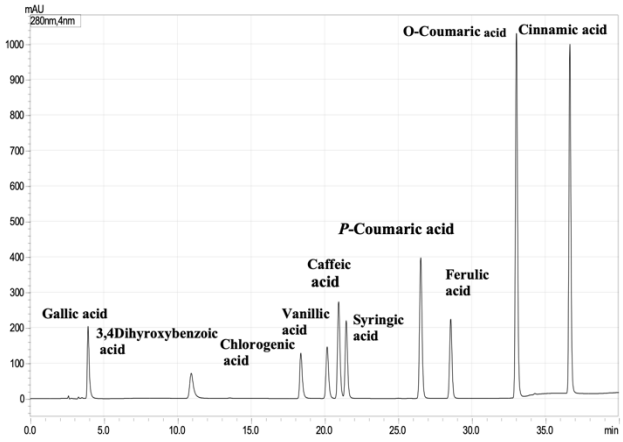

Fig. 3. Chromatogram of Phenolic Acid Standards Detected at 280 nm.

The highest chlorogenic acid contents were recorded in Madloki dates, and the values were 0.15 mg/g. It was followed by Barni dates (0.14 mg/g), Khalas dates (0.13 mg/g) and Fard dates (0.09 mg/g).

The concentrations of vanillic acid were observed as 0.32, 0.11, 0.19 and 0.25 mg/g dry weight in Barni, Khalas, Fard and Madloki dates, respectively. The highest (0.57 mg/g dry weight) and lowest (0.07 mg/g dry weight) concentrations of caffeic acid were noted in Fard and Khalas cultivars of dates, whereas Barni had 0.32 mg/g dry weight, and Madloki had 0.43 mg/g dry weight, respectively. Syringic acid was absent in Barni and Fard dates, but in Khalas it was 0.24 mg/g dry weight, and in Madloki it was noted as 0.11 mg/g dry weight. *P*-coumaric was not detected in Khalas and Madloki dates, and in both Barni and Fard, the concentration of *P*-coumuric acid was 0.05 mg/g dry weight. Ferulic acid was not found in khalas dates. For the other cultivars, it ranged from 0.11-0.17 mg/g dry weight, being highest in Madloki and lowest in Barni dates. Surprisingly, Fard dates had the highest (0.84 mg/g dry weight) concentration of O-coumaric acid, while the lowest (0.57 mg/g dry weight) concentration was observed in Khalas dates.

In Barni dates, O-coumaric acid concentration was 0.62 mg/g dry weight, and in Madloki it was observed as 0.81 mg/g dry weight. The Cinnamic acid was recorded as 0.07, 0.14, 0.20 and 0.28 mg/g dry weight in Barni, Khalas, Fard and Madloki dates, respectively (Table 1). Khalas date powder significantly had a higher concentration of detectable phenolic acid compounds than other date varieties (Fig. 4).

The gallic acid content of four different Omani date cultivars (Bunarinja, Faradh, Khasab, Khalas) ranged from 7.0 to 19.14 mg/100g on a fresh weight basis (Al Harthi *et al*., 2015), though our results are not comparable as we used different cultivars and analyses were done on dry matter basis. Similarly, Al Farsi *et al.* (2005) observed less gallic acid contents in Omani date varieties (Fard; 1.60 ± 0.02, Khalas; 3.09 ± 0.16 mg/100 g of fresh weight basis). Caffeic acid concentration was found to be higher in Fard and Khalas date as compared to Al-Harthi *et al*. (2015). They reported 0.02 mg/g fresh weight sample and 0.01 mg/g fresh weight sample caffeic acid in Fard and Khalas dates, respectively, while caffeic acid concentration was observed at 0.57 mg/g of dried weight sample in Fard date powder and 0.07 mg/g of dried weight sample in Khalas date powder. In the current study, the concentrations of vanillic acid were observed as 0.32, 0.11, 0.19 and 0.25 mg/g dry weight in Barni, Khalas, Fard and Madloki dates, respectively. In addition, the concentrations of syringic acid contents were observed at 0.11 and 0.19 mg/g dry weight in Khalas, and Fard dates, respectively. Previous studies from Omani Fard and Khalas cultivars of dates reported lesser concentrations of vanillic acid and Syringic acid, about 0.18 and 0.49 (mg/100 g of date flesh) in Khalas, respectively, and in Fard 0.27, 0.49 (mg/100 g of date flesh) respectively in comparison to our study (Al Harthy *et al*., 2015).

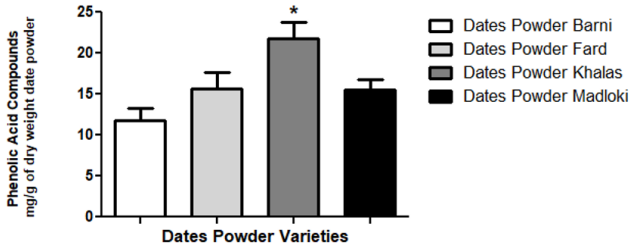

Fig. 4. Comparative Analyses of the Detectable Phenolic Acid Compounds in Date Powder using HPLC, *Significantly higher than other date varieties, $P < 0.05$.

3.3. *Analysis of flavonoid content using HPLC*

Different concentrations of flavonoid compounds in date cultivars were recorded and will be discussed hereunder. Rutin hydrate appeared at a retention time of 28.32 min, followed by quercetin at 36.56 and kaempferol at 38.19 min, Table 2. Only the Barni cultivar showed all three flavonoids: rutin hydrate, quercetin and kaempferol, while Khalas only showed rutin hydrate. A comparatively higher concentration of quercetin was observed in Madloki dates, and the value was 0.19 mg/g, while in Fard dates it was 0.15 mg/g, and in Barni dates it was 0.06 mg/g. Quercetin was not observed in the Khalas cultivar or rutin hydrate in the Madloki cultivar of dates. The concentration of rutin hydrate was 1.13 mg/g in Farad, 0.15 mg/g in Barani, and 0.02 mg/g in Khalas.

Kaempferol noted the highest concentration in Barni dates (0.022 mg/g). kaempferol content was 0.02 mg/g in Madloki, and it was not detected in either Fard or Khalas (Fig. 5). Fard date powder had a higher concentration of detectable flavonoid compounds in date powders, among other varieties, at about 1.287 mg/g, while Khalas date powder had the lowest detectable flavonoid, 0.019 mg/g (Fig. 6). The reasons for the differences in flavonoid content of the four different date cultivars might be attributed to their differences in carbohydrate content and genetics, as well as variation in soil cultivation.

The total flavonoid content of the types of Tunisian date differed considerably, Bejo and Deglet Nour varieties had 150.11 mg catechin/100 g and 58.92 mg catechin/100 g, respectively (Kchaou *et al*., 2014).

Table 1. Concentrations (mg/g dried weight sample) of major phenolic acids in date powder as determined by HPLC.

NO.	Compound	Formula	Retention Time (min)	Barni	Khalas	Fard	Madloki
1	Gallic acid	$(HO)_3C_6H_2CO_2H$	3.93	9.27	19.61	12.40	11.33
2	3,4-Dihydroxybenzoic acid	$(HO)_2C_6H_3CO_2H$	10.94	0.82	0.99	1.24	1.97
3	Chlorogenic acid	$C_{16}H_{18}O_9$	18.39	0.14	0.13	0.09	0.15
4	Vanillic acid	$HOC_6H_3(OCH_3)CO_2H$	20.18	0.32	0.11	0.19	0.25
5	Caffeic acid	$(HO)_2C_6H_3CH{=}CHCO_2H$	20.96	0.32	0.07	0.57	0.43
6	Syringic acid	$HOC_6H_2(OCH_3)_2CO_2H$	21.47	0.00	0.24	0.00	0.11
7	*P*-Coumaric acid	$HOC_6H_4CH{=}CHCO_2H$	26.54	0.05	0.00	0.05	0.00
8	Ferulic acid	$HOC_6H_3(OCH_3)CH{=}CHCO_2H$	28.57	0.11	0.00	0.13	0.17
9	O-coumaric acid	$C_9H_8O_3$	33.04	0.62	0.57	0.84	0.81
10	Cinnamic acid	$C_9H_8O_2$	36.67	0.14	0.07	0.20	0.28

Hamad *et al*. analyzed 12 Saudi date varieties (Ajwa Al Madinah, Khodry, Khlas Nabot Saif, Rashodia, Al Ahsa, Sokary, Khlas Al Kharj, Saffawy, Mabroom, NabtitAIi, Khla Al Qassim, Khals El Shiokh). Epigenin, luteolin, quercetin, isoquercetrin, and rutin were found in notable amounts (Hamad *et al*., 2015). Studies have shown that total flavonoid content decreases during maturity as fruits change from Khalal to Tamar (Amira *et al*., 2012; Lemine *et al*., 2014).

Table 2. Flavonoid Standards Used in HPLC Analyses at 280 nm.

Compound Name	Formula	Molecular Weight (g/mol)	Retention Time (min)	Area
Rutin hydrate	$C_{27}H_{32}O_{17}$	628.5	28.32	573294
Quercetin	$C_{15}H_{10}O_7$	302.236	35.656	881694
Keampferol	$C_{15}H_{10}O_6$	286.23	38.186	800534

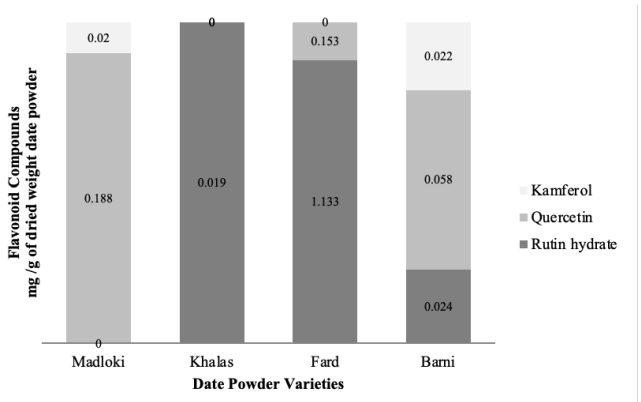

Fig. 5. Analyses of Flavonoid Compounds in (Madloki, Khalas, Fard and Barni) date Powder Using HPLC.

3.4. Analysis of Beta-carotene using HPLC

Carotenoids represent the yellow color of the date fruit, and it has been noticed that there is no improvement in the carotenoid concentration during the ripening of the fruits (Charoenchongsuk *et al*., 2018). They are precursors of vitamin A that exhibit a significant role in vision and protect the cells from the harmful impact of free radicals (Julia *et al*., 2015). The retention time of *β*-carotene was observed noted as 1.5 min (Figs. 7,8,9,10). Barni date powder had the highest concentration of *β*-carotene (8.81 mg/100g), followed by Khalas (2.52 mg/100g), Madloki (1.7 mg/100g) and Fard (1.79 mg/100g) (Fig. 11). The concentration of beta-carotene may differ due to innate differences between the different cultivars and maturation stages. The fresh (Rutab) Algerian dates (Deglet-Nour, Hamraya and Tantebouchte) were reported to have a higher concentration of beta-carotene than dried dates (Tamar) (Boudries *et al*., 2007). In a previous study on Omani dates, the Khalas dates had a comparatively higher concentration of *β*-carotene at the Rutab stage (3.03 mg/100 g on a fresh weight basis) compared to the Tamar stage (2.91 mg/100g of fresh weight). Likewise, in Fard dates, the total carotenoids decreased from 1.39 mg/100g in fresh dates to 1.19 mg/100g in dried dates at Tamar stage (Al Farsi *et al*., 2005). The composition of carotenoids was detected at three maturation stages for three different varieties (Khalal, Rutab, and Tamar) by Boudries *et al*. (2007); the lutein and *β*-carotene were observed as major carotenoids in all three varieties. Dried date fruit contain 0.97 mg/100 g of carotenoid compared to figs (0.03 mg/100 g) and apricot (2.20 mg/100 g) (Martín-Sánchez *et al*., 2014).

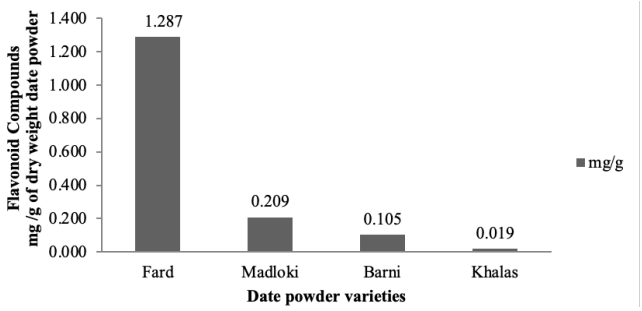

Fig. 6. Detectable Flavonoid Compounds in Date Powders Using HPLC.

3.5. HPLC Analysis of vitamin C in date powder

L-ascorbic acid retention time was 4.5 min (Figs. 12,13,14,15). Vitamin C, a water-soluble vitamin, acts as a potent antioxidant and protects from oxidative stress (Whitney and Rolfes, 2007). The vitamin C concentration was recorded as 0.25 to 0.64 mg/100 g of dry weight sample, the highest in Madloki dates and the lowest in Khalas dates. Fard and Barni date cultivars contained 0.63 and 0.29

mg/100 g of vitamin C, respectively (Fig. 16). Vitamins B-complex and vitamin C are major vitamins in dried date fruits (Al Farsi and Lee, 2008). Though, one very recent study did not find vitamin C in date fruits of different origins (Hinkaew *et al*., 2021).

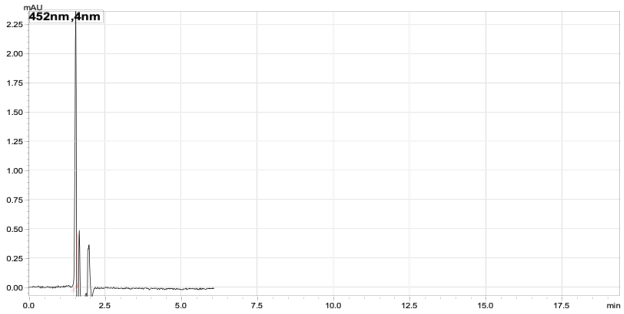

Fig. 7. *β*-Carotene Analysis of Barni Date Powder at 452 nm.

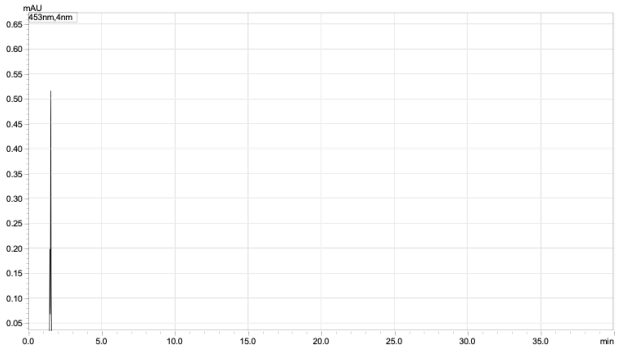

Fig. 8. *β*-Carotene Analysis in Khalas Date Powder at 452 nm.

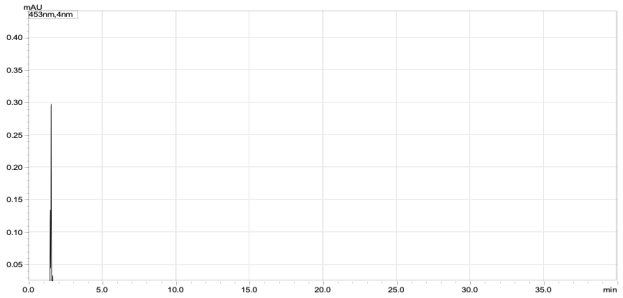

Fig. 9. β-Carotene Analysis in Fard Date Powder at 452 nm.

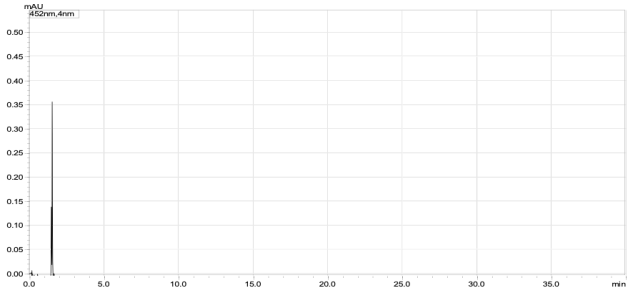

Fig. 10. *β*-Carotene Analysis in Madloki Date Powder at 452 nm.

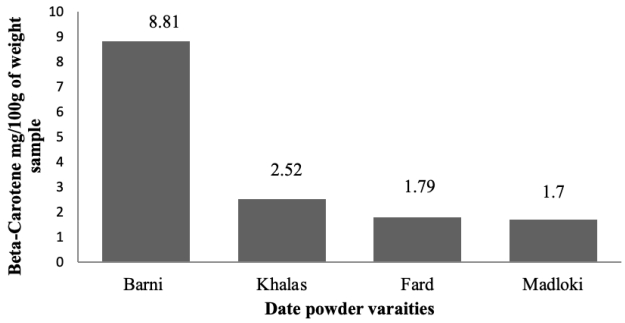

Fig. 11. Detectable Amount of β-Carotene in Date Powder.

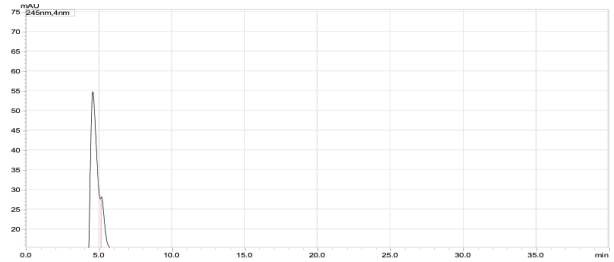

Fig. 12. L-Ascorbic acid in Madloki Date Powder at 245 nm.

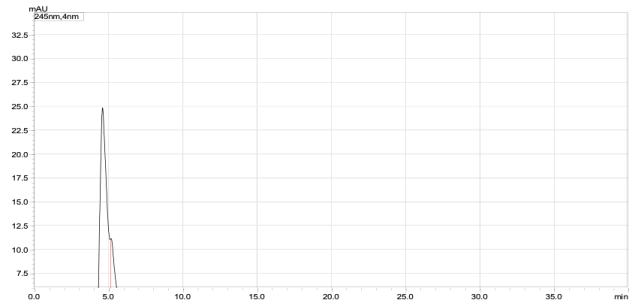

Fig. 13. L-Ascorbic acid in Fard Date Powder at 245 nm.

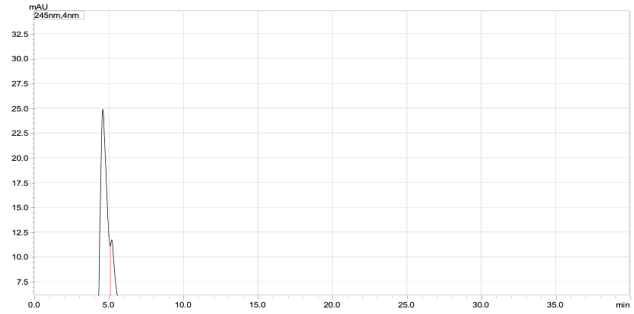

Fig. 14. L-Ascorbic acid in Barni Date Powder at 245 nm.

3.6. Qualitative analysis of tannins and saponins

A qualitative analysis was also done to check whether the studied date powder contained tannins and saponins. Tannins were not found in any of the date powders. Saponins, on the other hand, were found in all four date cultivars (Barni, Fard, Madloki, Khalas) (Table 3, Fig. 17). The results of qualitative analyses of tannins and saponins vary from those of other studies. Varietal differences and maturation stages may influence the saponins in dates. Yahaya *et al*. (2015)

analyzed five undefined fresh date varieties at Rutab stage for saponins, and only two of the five varieties showed saponins. Although in the current study, saponin was detected in all four date powders (Madloki, Fard, khalas, Barni). Algerian dates at Tamar stage (Deglet Nour, Ghars, Mech Degla) were reported to contain tannins (Amiour *et al*., 2018*)*. However, tannins were not detected in four date powders in the current study. Amiour *et al.* (2018) used a vanillin assay, while we used a butanol-HCL reagent to test for the presence of tannins. In a recent research, both tannins and saponins were found in significant amounts in different solvent extracts such as water, ethanol, n-hexane, and diethylethertannins (Temitope Olabisi and Ojotule, 2017). Therefore, the type of tests used for these analyses could explain the differences in the observed findings between the current study and others.

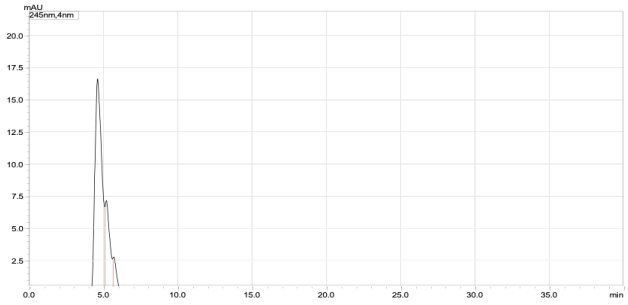

Fig. 15. L-Ascorbic acid in Khalas Date Powder at 245 nm.

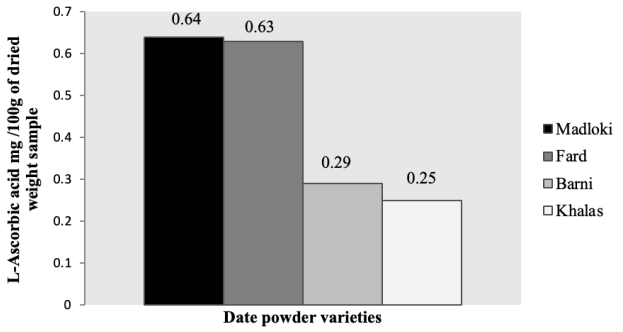

Fig. 16. The Detectable concentration of L-Ascorbic Acid in Date Powder.

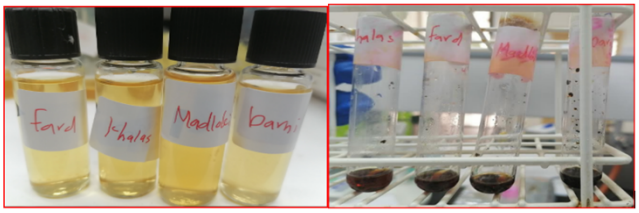

Fig. 17. Qualitative Analyses of Saponins and Tannins.

Table 3. Qualitative analysis of Saponins and Tannins. + = Presence, - = Absence.

Date Powder Varieties	Saponin	Tannin
Barni	+	-
Fard	+	-
Madloki	+	-
Khalas	+	-

4. Conclusion

Date powder can be considered nutraceutical due to its unique nutritional composition. Particularly Madloki date powder had the highest level of total phenolic content; the predominant phenolic acid in all the date powder was gallic acid (Madloki, Fard, Khalas, Barni). However, there were phenolic compounds that did not exist in date powder, such as Syringic acid in Barni and Fard date powder and Ferulic acid in Khalas date powder. Based on the present investigation, the concentration of flavonoid compounds showed in trace amounts compared to phenolic acid compounds because flavonoid content decreased during maturities. Vitamin C and β-carotene concentrations varied among date varieties. Capsulation of date powder might be an appealing approach in the food and health industry. It can be concluded that our work elaborates on extended scientific information on phytochemical analyses of commonly grown Omani date varieties.

Conflict of interest

The authors declared that they have no conflict of interest.

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