

Composition and Biological Activities of different Date Seed varieties (*Phoenix dactylifera*) of Oman: Cultivation Zone Influence

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Abstract

Date (*Phoenix dactylifera* L.) seeds (pits) account for ca. 10% of the date fruit and it is the date pits that present a major problem to the date palm industry in the USA as a waste product. Currently date pits are employed as a food source for animals and poultry, as a soil fertilizer and also as a road base gravel. In order to understand the varietal effects of Omani date seeds on the nutritional properties of dates and to explore the use of this waste product from the food industry, twenty two native date seeds (*Phoenix dactylifera* L.) including the varieties; Qushbu Narenjahn, Fardh, Naghal, Manhi, Qush Balquan, Helali Oman, Khasab, Seedi, Qush Jabrin, Khalas, Qush Basrah, Qushbu Maan, Handal, Khunaizi, Qush Mamoor, Barshi, Barni, Azad, Zabad, Qush Tabak, Qush LuLu, and Halali Alhasa were collected from six regions of the Sultanate of Oman and were examined for their nutritional value, antioxidant and urease properties. Energy values, dry matter, and carbohydrate level were the predominant components examined in the date seeds, followed by fiber, moisture, along with small amounts of ash, protein, and fat. The results of the 22 varieties of date seeds showed a significant energy value of between 283.0 to 407.9 kcal/100g, dry matter of between 93.3%-96.3%, carbohydrate content of between 43.8%-80.6%, moisture in the range of 4.3%-6.6%, fat in the range of 5.0%-10.9%, ash content of between 0.73%-1.08%, protein content of 0.2%-6.9% and fiber content of between 5.0%-32.5%. Furthermore the antioxidant potential ranged between 7.4 - 88.3% depending upon the type of date seeds and location of samples. In this regard the Handal date seeds collected from Al-Hamra showed the highest antioxidant potential with 88.3% inhibition. Similarly urease inhibition ranged from 0.94-70.3% and Qush Tabak date seeds collected from Al-Hamra demonstrated the highest urease potential with 70.3% inhibition. It is noteworthy that Qush Basrah, Seedi, Qush Balquan, and Handal date seeds have significantly higher nutritional attributes compared to the rest in the study group. Moreover Fardh, Khasab, Khalas, and Handal date seeds collected from more than one region of Oman showed variation in some nutritional values. The nutritional analysis further demonstrated the correlation of proximate parameters in different regions of Oman. Results of the current investigation indicate a promising and significant potential for date seeds to be used as a supplementary source of a healthy diet as well as in specific pharmaceutical applications.

Keywords: Dates; (*Phoenix dactylifera* L.) seeds (pits); Nutritional value; Antioxidant property; Urease property; Energy values; Dry matter; Carbohydrate level

Introduction

It has been reported that the date palm (*Phoenix dactylifera* L.) has been employed in cultures since 4000 BC or 2000-3000 BC in different parts of the world since they play a crucial role both in societal life as a food or in food-making as well as in the treatment of various diseases. The genus *Phoenix* has many species but

since the fruits of *P. dactylifera* are both most tasty and edible, it is the most cultivated varietal in the world. The fruits of other *Phoenix* species are mostly eaten by animals and birds [1]. People of Oman considered *P. dactylifera* as the foremost crop in Oman where it represents 84.9% of the total fruit industry and occupies 49.3% of the total agricultural land. It has been reported Oman produced 298000 ton in 2001 which decreased in 2002 and 2003 due to

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limited resources experienced by the producers but again increased to 265000 ton in 2008 [2]. In recent times a commercial date-pit powder has been developed for the coffee market [3].

Previously Besbes *et al.* studied the moisture, ash, fats, fiber, proteins, carbohydrates, proximate analysis, and antioxidants of the seeds of two different date seeds (*P. dactylifera*) of Tunisia (Deglet Nour and Allig) [4,5]. Moreover Nehdi *et al.* also performed physicochemical analyses of date palm seeds and oils of Tunisian origin (*P. canariensis*) [6]. In another study Habib and Ibrahim [7] studied the chemical and physical properties of seeds of eighteen date (*P. dactylifera*) varieties and Hamada *et al.* [8] and Rahman *et al.* [9] conducted the above mentioned study of three date seed varieties collected from the United Arab Emirates. Furthermore Abdalla *et al.* investigated the physico-chemical characteristics of date seed oil of two date varieties grown in Sudan [10]. However some authors also investigated date seed oil of UAE origin for its fatty acid profiles and vitamin content [3,11]. Very few reports have been published about physicochemical studies of different date varieties of Oman. For example Al-Farsi *et al.* reported the total phenolics, proximate composition, dietary fibre, and total antioxidant activity of three different date varieties viz., Mabseeli, Um-sellah, and Shahal collected from the Batinah region of Oman [12a], while Suresh *et al.* [13] reported on the thermal study, chemical composition and total polyphenol composition of two date seeds viz., khalas and tamar [13].

It has been reported that the relative composition of some nutrients and minerals in dates can differ depending on climate conditions and soil composition [14]. Moreover date fruits of different origin viz., United Arab Emirates, Bahrain, Kuwait, Iran, Pakistan, Egypt, and Saudi Arabia were shown to have a variation in this composition in different cultivars [15]. We have recently reported a nutritional analysis and antioxidant activity of 22 date fruits of Oman which showed significance differences in variation in composition [15]. Since the date palm industry is the major agricultural activity of Oman, the main objective of this study was to determine the nutritional (moisture, ash, fats, fiber, proteins, carbohydrates and energy value), and anti-nutritional (total antioxidants, total polyphenols, total flavonoids, and total carotenoid contents) values of 22 date seed varieties cultivated in six different regions of Oman.

Material and methods

Sample collection and identification

Twenty-two different varieties of date palm fruits were collected from the Al Dakhliya region in the Sultanate of Oman and identified by an expert botanist. Among the 22 varieties, thirteen (Fardh, Helali Oman, Manhi, Qush Basrah, Handal, Naghal, Qush bu Maan, Qushbu norenjah, Qush Balquan, Qush Jabri, Seedi, and Khasab) were collected from Bahla; eight (Khunaizi, Barshi, Qush Mamoor, Barni, Fardh, Khasab, Handal, and Azad) from Adam; six (Zabad, Khasab, Khalas, Naghal, Fardh, and Handal) from Bidbid;

two (Handal & Qush Tabak) from Al-Hamra, one (Qush Lulu) from Manah and one (Halali Alhasa) from Samail. The seeds were removed from the fully matured and dry fruits (Tamar stage), cleaned by boiling them in water for an hour and sun dried for 4 to 6 days based on weather condition and were stored at room temperature in air tight containers prior to analysis.

Nutritional analysis

Nutritional analysis was performed using the standard methods of AOAC [16]. Moisture content was determined gravimetrically by drying the sample in an oven (WiseVen, WON-50, Korea) at 105 °C until it attained a constant weight [17]. Protein content was determined in terms of nitrogen by the micro Kjeldahl method (Buchi, KjeldFlex K-360, Switzerland), using the general conversion factor 6.25 [18,19]. Fat content was determined by extracting the seeds with *n*-hexane and evaporating off the solvent and drying the residue at 103 °C [15]. Total ash was expressed in percentage of dry weight by heating samples at 550 °C in a muffle furnace (Wise Therm, FHP- 03, Korea) for 6 h. The crude fiber was determined by the method reported by Hussain *et al.* (2012). The energy value was calculated according to the equation: Energy = (% protein 4) + (%fat 9) + (% carbohydrate 4) [15,19].

Measurement of total Carotenoids

Total carotenoids were determined using the method of Talcott and Howard (1999) with a slight modification. The sample (0.5 g) was extracted using 5 ml of a solution (400 ml acetone/ethanol (1:1, v/v) with 3.2 g of BHT: Butylated Hydroxy Toluene) under a yellow fluorescent light to avoid light-induced changes. Different concentrations of the samples (25, 50, and 100%) were prepared. The extract was centrifuged at 1500 rpm for 15 min at 4-5 °C and the supernatant was collected. The remaining residue was re-extracted using the same method until the residue was colorless. Finally, the combined supernatants were extracted with EtOAc, and the absorbance at 470 nm was measured using a Spectrophotometer (LASA). Total carotenoids were calculated according to the method of Gross (24), using the following equation, and expressed as milligrams per 100 g of fresh weight.

$$\text{Total carotenoids (mg/g)} = \frac{Ab}{V} \times 10^6 / A^{1\%} \times 100 G$$

Ab is the absorbance at 470 nm, V is the total volume of extract, A^{1%} is the extinction coefficient for a 1% mixture of carotenoids at 2500, and G is sample weight (g).

Measurement of total phenolics

0.2 g of seed samples were added to 2 ml of methanol, vigorously shaken and the supernatant was collected. The remaining residue was re-extracted with a further 2 ml of methanol. Different concentrations of each sample (50, 100 and 200 µl/ml)



were prepared. 50µl of FCR: Folin-Ciocalteu reagent and 500 µl of Na₂CO₃ were added successively. After incubation for 30 minutes, the supernatant was collected and the absorbance measured at 725 nm.

Measurement of total flavonoids

0.2 g of seed samples were shaken up with 3.4 ml of 30% aqueous MeOH. To this mixture was added 0.15ml of NaNO₂ and 0.15ml of AlCl₃ were added and the mixture incubated for 30 minutes in the dark. After incubation 1ml of NaOH was added and the mixture was vigorously shaken and incubated for a further 30 minutes. The supernatant was collected and the absorbance measured at 510 nm for 200µl, 100µl and 50µl of extracts.

Measurement of total antioxidant

0.1g of seed sample was mixed with 5ml of a reagent comprising 0.6M H₂SO₄, 28mM Sodium Phosphate and 4mM Ammonium Mylobdate. The mixture was shaken and sonicated for 5 minutes. After incubation for 30 minutes, the samples were centrifuged three times and the supernatant was collected and the absorbance measured at 695 nm.

Results and Discussion

The data showed that the moisture content was higher ($P < 0.05$) for Qush Tabak date seeds (6.67) collected from Al-Hamra compared to other date seeds. Interestingly, a previous study by our group showed that the moisture content was also higher (21.65) in Qush Tabak date fruits [15]. Moreover, handal date seeds collected from Bahla have the second highest moisture content (6.43) and interestingly, similar types of date seeds collected from Al-Hamra have a lower moisture content (4.87) compared to Bahla handal date seeds. On the other hand, handal date seeds collected from Adam (5.23) and Bidbid (5.43) have a similar moisture content but lower than handal date seeds collected from Bahla.

Fardh date seeds collected from three different regions of Oman have an almost similar moisture content viz., Bahla (5.64), Adam (5.11), and Bidbid (5.01). On the other hand Fardh date seeds collected from the UAE have the highest moisture content (8.69) compared to the 22 grades from Oman [7]. A previous study showed that three date seed varieties from the Batinah region of Oman viz., Mabseeli, Um-sellah, and Shahal have a similar range of moisture content as the 22 grades of the current study [12a]. Khasab date seeds collected from two regions have a similar moisture content viz., Adam (5.11) and Bidbid (5.07) but Khasab date seeds collected from Bahla have a much lower moisture content (3.62). Moreover the Khalas date seeds collected from two different regions have quite different moisture contents viz., Bahla (4.33) and Bidbid (5.24). On the other hand Khalas date seeds collected

from the UAE have the highest moisture content (7.1) compared to the 22 grades of Oman [8]. The moisture content ranged from 4.33-6.67% in all 22 different date seeds in the current investigation.

The dry matter composition was higher for the date seeds Khasab and Qushbu collected from Bahla while Qush Balquan (Bahla), Seedi (Bahla), Khalas (Bahla), Qushbu Maan (Bahla), Khunaizi (Adam), Qush Mamoor (Adam), Barshi (Adam), Azad (Adam), Zabad (Bidbid), Naghal (Bidbid), Qush Lulu (Manah), and Handal (Al-Hamra) had slightly lower dry matter than the former mentioned seeds but have higher dry matter composition than remaining date seeds. Moreover, the dry matter composition ranged from 96.3 to 93.3% in various date seeds and interestingly, a previous study by our group showed that dry matter composition ranged from 78 to 86% in 22 grades date fruits [15]. Qush Tabak (Al-Hamra), Handal (Bahla), Qush Jabrin (Bahla) and Qush Basrah (Bahla) had a lower dry matter composition compared to all other date seeds (Table 1). Notably, the dry matter gradually increased in Fardh and from Bahla to Adam and Adam to Bidbid (Table 1).

The ash content was higher in the date seeds of Naghal and Fardh growing in the Bahla and Bidbid areas respectively. It was followed by Qush Basrah Khalas growing in Bidbid which the ash content ranged from 0.73-1.08% in all varieties collecting from six different areas of Oman. On the other hand, the fibre content in Fardh was similar when collected from Bahla and Adam but higher when collected from the Bidbid area. Similarly the fibre content in Khasab date seeds was similar when collected from Bahla and Bidbid but higher when collected from the Adam area. Moreover, the ash content of Fardh date seeds collected from the UAE was higher than that collected from Oman. However the Omani Khalas date seeds have a higher ash content than Khalas collected from the UAE [7]. In another study by Hamada et al [8] they reported that Khalas date seeds collected from the UAE have a higher ash content than the Omani varietal.

The fibre composition was higher in Helali Oman (Bahla), Khalas (Bahla), and Barshi which were collected from Adam. The fibre composition in the date seeds usually ranges from 3.5-4.42%. However, our study indicated fibre composition in date fruits to range from 1.0-2.5% [15]. Indeed the Seedi and Qush Basrah variety of date seeds collected from Bahla has an even lower composition of fibre (Table 1). On the other hand the fibre content in Fardh was almost similar to date seeds collected from Bahla and Bidbid but higher in Adam area. Similarly the fibre content in Khasab date seeds was similar when collected from Adam and Bidbid areas but significantly higher from the same varietal collected in the Bahla area. Further analysis showed that the fibre content in Handal date seeds was similar to the same varietal collected from the Bidbid and Al-Hamra areas but lower when collected from the Bahla and Adam areas.

Date seeds of Qush Jabrin (Bahla), Qush Basrah (Bahla), Handal (Bahla), Fardh (Bidbid), Qush Lulu (Manah) have a higher ($P < 0.05$) fat content compared to other varieties. It is interesting to note that the fat content in various date seed varieties ranged from 10.9 to 51% while previously it has been reported that the fat content in

varieties of date fruits ranged from 0.1 to 0.7% [15]. On the other hand Naghal and Khalas date seeds collected from Bahla have much lower levels of fats. On the other hand the fat content in Fardh date seeds was similar to that collected from Bahla and Bidbid but lower from the Adam area. Moreover the fat content of Khasab date seeds was similar to that when collected from the Bahla, Adam Al-Hamra and Bidbid areas. Further analysis showed that fat content in Handal date seeds was similar to that when collected from the Bahla, Adam, and Al-Hamra areas but lower in the same varieties collected from Bidbid. Moreover the fat level of Fardh date seeds collected three regions of Oman viz., Bahla, Adam, and Bidbid was higher than Fardh date seeds collected from the UAE [7]. In an earlier study, Hamada et al [8] reported that Fardh date seeds collected from the UAE had a higher fat content than Fardh date seeds collected from Bahla and Adam but was lower when collected from Bidbid. Furthermore the fat level of Khalas date seeds collected in the Bidbid area was higher than Khalas date seeds collected from the UAE [7].

The protein content in the date seeds was significantly higher in Fardh (Adam), Manhi (Bahla), and Qush Lulu (Manah) while lower in Khasab (Bahla), Khalas (Bidbid), Zabad (Bidbid), Qush Mamoor (Adam), Seedi (Bahla), Barshi (Adam), and Qush Jabrin (Bahla). The protein level ranged from 0.19-6.91% and between 1.8-3.8% in date fruits [15]. Further analysis showed that the protein content in Handal date seeds was similar when collected from the Bahla, Adam, Bidbid, and Al-Hamra areas. On the other hand the protein content in Handal date seeds was similar when collected from the Adam and Bidbid areas but higher when collected from the Bahla area. Moreover, Khasab and Khalas date seeds showed a variation in protein content when collected from two different regions of Oman. Thus the protein content of Fardh date seeds collected from the Adam area was higher than that of Fardh date seeds collected from the UAE [7] but lower when collected from the Bahla and Bidbid areas. On the other hand the protein level of Khalas date seeds collected from the Bahla and Bidbid areas was lower than Khalas date seeds collected from the UAE [7,8].

The carbohydrate content was significantly higher in Seedi date seeds collected from the Bahla area followed by Barni and Zarbad date seeds collected from the Adam and Bidbid areas respectively. On the other hand Qush Lulu and Naghal date seeds collected from the Manah and Bidbid areas have a lower carbohydrate content. Further analysis showed that carbohydrate content in Handal date seeds was similar when collected from the Bahla, Bidbid, and Al-Hamra areas but higher in Handal date seeds collected from the Adam area. On the other hand the carbohydrate

level in Handal date seeds was similar to the same variety collected from the Bahla, Al-Hamra and Bidbid areas but higher when collected from the Adam area. Moreover Khasab date seeds did not demonstrate much variation in carbohydrate level when collected from three different regions of Oman while Khalas date seeds showed a variation in carbohydrate level when collected from two different regions. The carbohydrates level in the date seed varieties ranged between 43.8-80.6% when collected from different locations

The energy values showed that the Qush Basrah date seeds growing in the Bahla region are the highest ($P < 0.05$) and is followed by Seedi (Bahla), Qush Balquan (Bahla), Handal (Adam), and Halali Alhasa (Samail) (Table 1). On the other hand Halil Omani, Barshi, and Qush Lulu (Manah) date seeds have lower energy values as compared to other date seeds. Energy values ranged from 283.0 to 407.9 kcal/100 g in all the date seed varieties investigated. Further analysis showed that the energy value in Handal date seeds was similar when collected from the Bidbid and Al-Hamra regions but much higher in Bahla and Adam's Handal date seeds. On the other hand the energy value of Fardh date seeds was similar in the same varieties of date seeds collected from the Bahla and Adam regions but higher when collected from the Bidbid region. Interestingly, Khasab date seeds showed a large variation in energy values when collected from three different regions of Oman while Khalas date seeds showed a large variation in energy value when collected from two regions.

Khunaizi date seeds collected from the Adam region have the highest total carotenoids content (Figure 1) with a value of 67 mg/g and this was followed by Fardh (Bahla and Bidbid) and Khalas (Bahla). On the other hand, the highest carotenoid content was reported from Omani Khalas date fruits [12b]. Also found was that the Qush mamoor (Adam) and Halali Alhasa (Samail) date seeds have the lowest carotenoid content among all 22 of the date seeds of Oman investigated in this study. Further analysis showed that the carotenoid contents in Handal date seeds was similar when collected from the Bahla and Adam regions but was below the detection limit in Handal seeds collected from the Bidbid and Al-Hamra regions. On the other hand, the carotenoid content in Fardh date seeds was similar in date seeds collected from the Bahla and Bid regions but below the detection limit when collected from the Adam region. Moreover Khalas shows a large variation in carotenoid contents when collected from the Bahla and Bidbid regions the same date seeds has a similar carotenoid content when collected from the Adam and Bidbid regions.



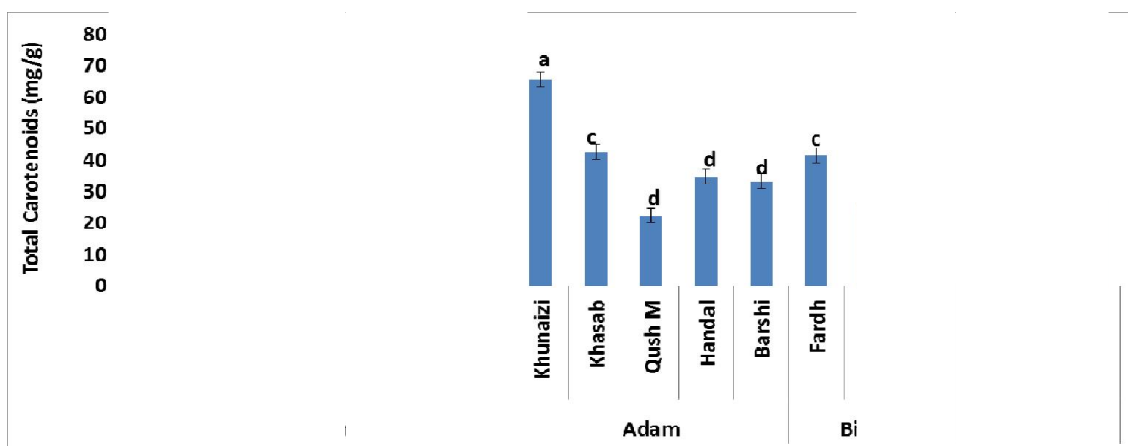


Figure 1.Total carotenoid contents of seeds in various varieties grown in different parts of Oman. ± refers to standard error of the mean values. The different letter in each column shows that the values are significantly different ($P < 0.05$) as performed by the Duncan Multiple Range Test (DMRT) using statistical analysis software (SAS version 9.0; USA). Each analysis is performed three times with three replicates.

The Qush Basrah date seeds collected from Bahla have the highest total flavonoid content (Figure 2) at a high concentration (3.1 mg/g dry weight at 100%) while its value decreases to half at low concentration (50%) and this was followed by Handal (Adam and Bidbid), Fardh (Bahla), Qush Tabak (Al-Hamra), and Khalas (Bidbid). On the other hand Naghal (Bahla), Khunaizi (Adam), Qush Lulu (Manah) have the lowest total flavonoid content among all the

22 evaluated date seeds of Oman. Furthermore the total flavonoid content in Handal and Fardh date seeds showed a large variation when collected from the Bahla, Adam, Al-Hamra and Bidbid regions. Moreover Khalas date seeds show a large variation in flavonoid content when collected from the Bahla and Bidbid regions while the same varieties have similar flavonoid contents when collected from the Adam and Bidbid regions.

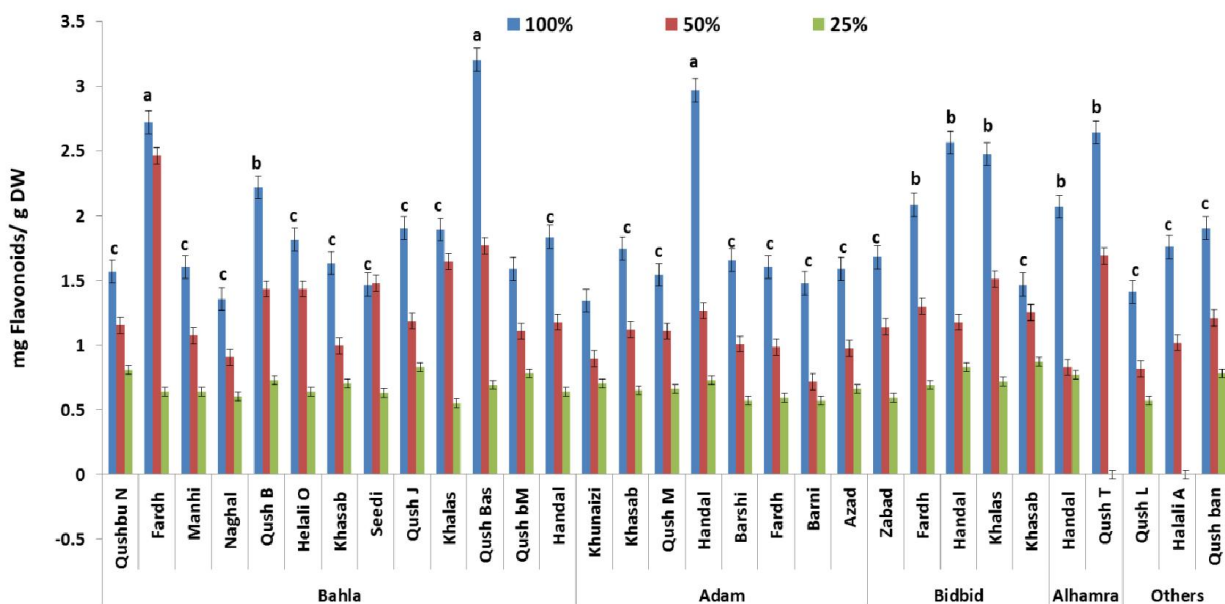


Figure 2.Total flavonoid contents of seeds in various varieties grown in different parts of Oman. ± refers to standard error of the mean values. The different letter in each column shows that the values are significantly different ($P < 0.05$) as performed by the Duncan Multiple Range Test (DMRT) using statistical analysis software (SAS version 9.0; USA). Each analysis are performed three times with three replicates.

Further data illustrated that all 22 date seeds investigated in this study have a similar total phenolic content (Figure 3). Interestingly,

Qush Basrah (Adam) and Halali Alhasa (Samail) have the highest total phenolic contents while Handal date seeds collected from

Bidbid have the highest total antioxidant contents (Figure 4) which was followed by Khalas (Bidbid) and Qush Balquam (Bahla). On the other hand Qush Narenjah (Bahla), Barshi (Adam), and Naghal (Bahla) have the lowest total antioxidant contents among all the 22 date seeds studied in this investigation. The total antioxidant content in Fardh date seeds showed a large variation in antioxidant contents when collected from the Bahla, Adam, Al-Hamra and Bidbid regions. Moreover Khalas date seeds showed a large variation in antioxidant contents when collected from the Bahla and Bidbid regions while they have a similar antioxidant content when collected from the Adam and Bidbid regions. Moreover the antioxidant content in Handal date seeds was similar when collected from the Bahla, Adam, and Al-Hamra regions but higher for seeds collected from the Bidbid region. On the other hand, the antioxidant content of Fardh date seeds was similar when collected from the Bahla and Adam regions but only slightly higher in seeds collected from the Bidbid region. Moreover Khalas date seeds show a large variation in antioxidant content when collected from the Bahla and Bidbid region while being similar when collected from the Bahla and Adam regions and lower in the Bidbid region. The results of antioxidant and urease enzyme activities of water and MeOH extracts of the 22 date seeds in this investigation

showed that they had moderate activities compared to standard drugs. The Handal date seeds from Al-Hamra demonstrated high antioxidant potential (88.3%) in the MeOH extract compared to other date seed varieties (Table 2). The same variety of date seed collected from the Bahla, Adam, and Bidbid regions showed lower activity than the former region. However a water extract of Handal date seeds collected from Bahla displayed a significant antioxidant potential of 81.3%. Moreover a water extract of Barshi date seeds collected from the Adam region demonstrated significant antioxidant potential (81.5%) followed by Khasab (Bidbid) with 78.7% and Qush Tabak (Al-Hamra) with 73.7% inhibition. Moreover Khasab date seeds collected from the Adam and Bahla regions showed only a weak antioxidant activity. On the other hand, only Qush Tabak date seeds from the Al-Hamra region showed significant urease inhibition with a value of 70.3%. On the other hand Handal date seeds (Al-Hamra) displayed a higher activity in both the methanol and water fraction while the same variety collected from the Bidbid, Bahla and Adam regions had lower activities in all three fruit extracts. The antioxidant potential ranged between 4 and 88% while the urease inhibition ranged between 1.0 and 70.3% depending upon the type of date varietal and location.

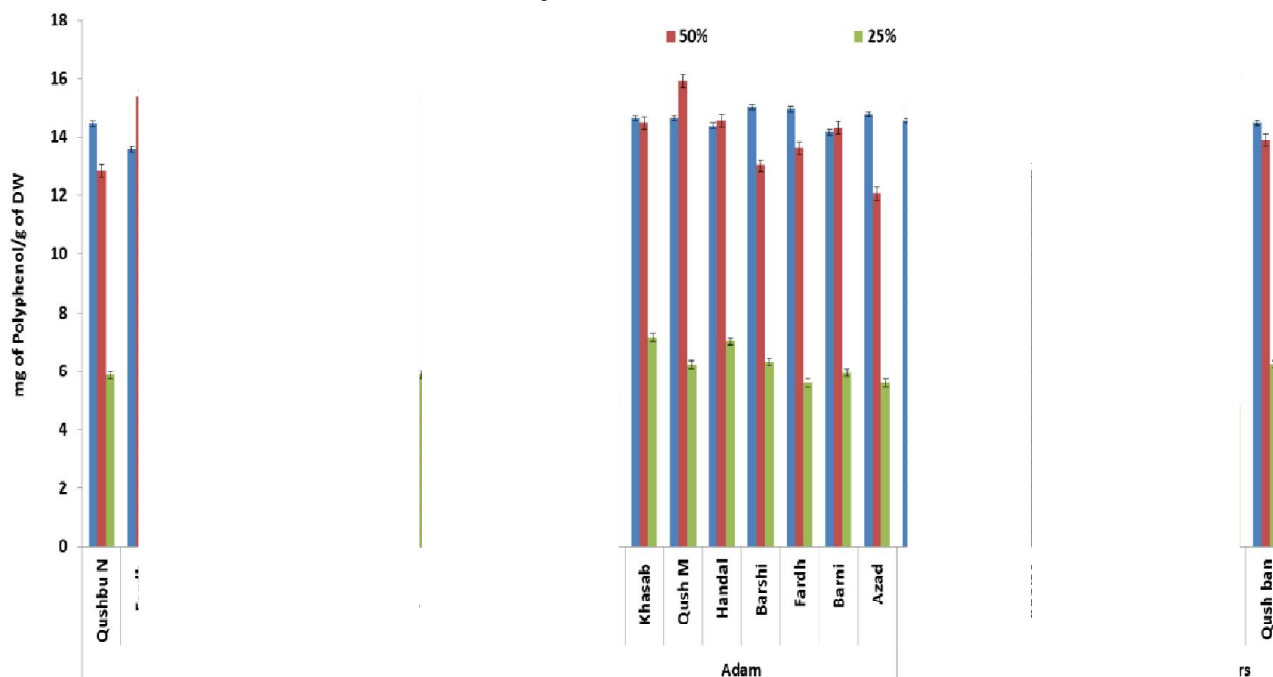


Figure 3. Total polyphenol contents of seeds in various varieties grown in different parts of Oman. The bars show standard error of the mean values. Each analysis is performed three times with three replicates.

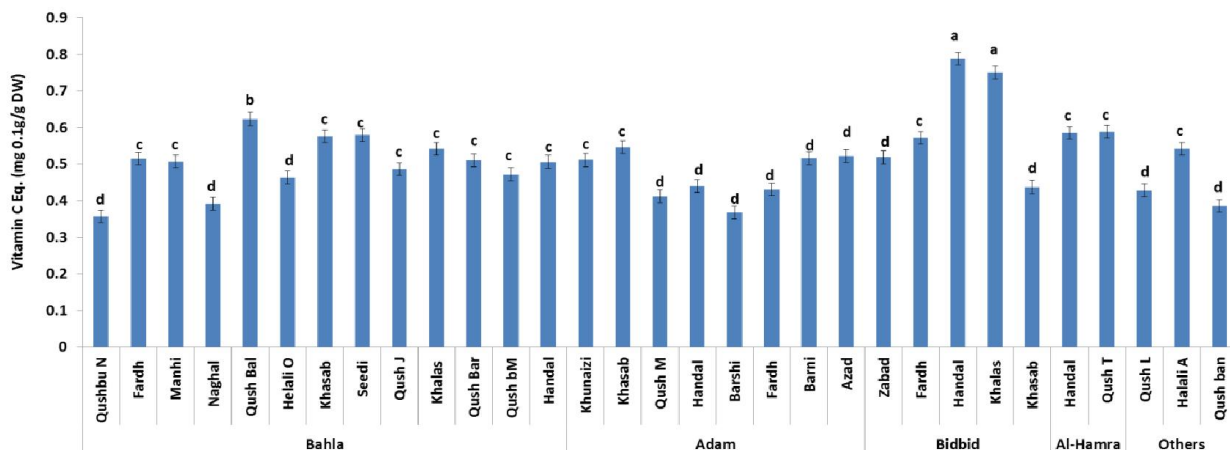


Figure 4. Total antioxidant contents of seeds in various varieties grown in different parts of Oman. ± refers to standard error of the mean values. The different letter in each column shows that the values are significantly different ($P < 0.05$) as performed by the Duncan Multiple Range Test (DMRT) using statistical analysis software (SAS version 9.0; USA). Each analysis are performed three times with three replicates.

Table 1: Proximate analysis of various varieties of date-pits powder growing in Oman

S.No	Samples	Moisture	Dry Matter	Ash	Fats	Proteins	Fiber	Carbohydrates	Energy Value
Bahla	Qushbu Narenjah	4.16c	95.84a	0.74	6.52e	5.55b	18.01f	64.32d	338.16c
	Fardh	5.64b	94.36b	0.86	9.05b	4.21c	18.79f	61.18de	343.03c
	Naghal	5.47b	94.53b	1.08	5.51f	1.21e	19.03e	67.29c	323.53cd
	Manhi	5.17b	94.83b	0.74	7.89d	6.31a	17.38f	61.85e	343.69c
	Qush Balquan	4.74c	95.26a	0.93	9.37b	5.75b	6.95h	72.02b	395.42a
	Helali Oman	5.81b	94.19b	0.87	8.01c	2.25d	32.51a	50.51g	283.05ef
	Khasab	3.62d	96.38a	0.76	8.17c	0.19f	16.11fg	70.86b	357.77c
	Seedi	4.78c	95.22a	0.77	8.86c	0.43f	4.42i	80.61a	403.95a
	Qush Jabrin	5.92b	94.08b	0.89	10.56a	0.59f	14.51g	67.21c	366.25b
	Khalas	4.33c	95.67a	0.91	5.14g	5.66b	28.27c	55.36f	290.32e
Adam	Qush Basrah	5.97b	94.02b	0.92	10.89a	5.48b	4.99i	71.99b	407.89a
	Qushbu Maan	4.81c	95.19a	0.81	7.29d	5.41b	12.41g	69.26c	364.28b
	Handal	6.43a	93.56b	0.85	10.12a	5.28b	11.86gh	65.51d	374.26b
	Khunaizi	4.63c	95.37a	0.73	8.73c	1.48e	19.23e	64.94d	344.31c
	Khasab	5.11b	94.88b	0.87	8.84c	1.08e	10.97gh	72.88b	375.47b
	Qush Mamoor	4.51c	95.49a	0.79	7.98d	0.43f	21.11d	65.11d	334.04c
	Handal	5.23b	94.76a	0.78	9.42b	5.18b	6.21h	73.7a	397.81a
	Barshi	4.65c	95.35a	0.84	8.38c	0.53f	31.46b	54.32ef	294.87e
	Fardh	5.11b	94.88b	0.85	7.61d	6.91a	21.95d	57.52e	326.16cd
	Barni	5.06b	94.93b	0.81	8.01c	5.84b	5.29h	74.66a	394.14a
Bidbid	Azad	4.81c	95.19a	0.73	6.24e	4.77c	19.72e	63.44d	329.03cd
	Zabad	4.96c	95.04b	0.79	8.15c	0.34f	11.38gh	74.37a	372.28b
	Naghal	4.86c	95.13a	0.81	7.29d	5.37b	26.22c	55.53ef	309.24d
	Fardh	5.01b	94.99b	0.97	10.62a	1.81e	18.95e	62.18d	351.61c
	Handal	5.43b	94.57b	0.75	7.71d	5.34b	17.34e	63.23d	343.67c
Al-Hamra	Khalas	5.24b	94.76b	0.86	9.87b	0.28f	9.88h	73.43a	383.68b
	Khasab	5.07b	94.93b	0.77	7.57d	5.31b	12.166gh	68.78c	364.51b
	Qush LuLu (Manah)	4.94c	95.06a	0.79	10.59a	6.18a	33.61a	43.86g	295.59e
	Halali Alhasa (Samail)	5.29b	94.71b	0.89	8.89c	5.19b	5.99h	73.41a	394.42a
Others	Handal	4.87c	95.13a	0.89	9.14b	5.53b	18.97e	60.34d	345.77c
	Qush Tabak	6.67a	93.33c	0.87	7.94d	1.58e	11.42gh	71.48b	363.77c

The values in the table represent mean of three replications. The different letters in each column of each parameter shows a significant difference among the same group. This significant difference was evaluated by using Duncan Multiple Range Test with $P < 0.05$, using SAS software ver 9.0. Using the same analysis, values of "Ash" for different date palm seeds did not identified a statistical difference among mean values



Table 2. Antioxidant and urease activities of date seeds

Region	Samples	Urease (MeOH)	Antioxidant (MeOH)	Antioxidant (Water)	Urease (Water)
Bahla	Qushbu Narenjah	14.15	7.45	SDa	37.65
	Fardh	25.71	39.27	SD	SD
	Naghal	0.94	NA	SD	SD
	Manhi	32.31	23.43	SD	SD
	Qush Balquan	42.09	41.81	35.41	46.97
	Helali Oman	31.25	24.95	32.87	47.62
	Khasab	13.79	4.18	56.05	27.37
	Seedi	37.85	54.74	SD	SD
	Qush Jabrin	NA	19.29	SD	SD
	Khalas	30.18	31.71	33.81	SD
	Qush Basrah	28.54	12.09	14.79	38.59
	Qushbu Maan	18.63	21.68	66.43	43.67
	Handal	25.82	15.58	81.33	53.28
	Adam	Khunaizi	24.29	27.64	48.26
Khasab		34.08	28.08	54.52	43.95
Qush Mamoor		29.48	27.13	SD	SD
Handal		24.53	45.29	SD	SD
Barshi		3.18	10.71	81.59 ; IC ₅₀ : 424 (µg/ml)	51.58
Fardh		18.63	27.35	51.59	25.67
Barni		38.56	62.22	SD	SD
Azad		22.29	NA	66.38	43.15
Bidbid	Zabad	22.29	12.68	47.67	31.74
	Fardh	35.49	48.27	SD	SD
	Handal	37.62	23.06	SD	SD
	Khalas	32.43	50.09	SD	SD
	Khasab	NA	NA	78.69	37.79
Al-Hamra	Handal	12.5	88.32 ; IC ₅₀ : 125 (µg/ml)	SD	SD
	Qush Tabak	28.30	27.27933	73.73386	70.38 ; IC ₅₀ : 572 (µg/ml)
Others	Qush Lulu (Manah)	22.28	64.98	24.68	41.01
	Halali Alhasa(Samail)	21.23	19.79	SD	SD
		32.19	31.35	SD	SD

^aSD: The sample was damaged

Figure 5 shows the PCA plot of different varieties of date's seeds samples and it can be seen from the PCA (Principal Component Analysis) plot that on PC1 the main variation is due to varieties Naghal and Qush LuLu. It shows that these two are different varieties from others. While on the PC2 the variation is due to Helali Oman, Barshi, Khalas are in one group are different from varieties Qush Basrah.

Conclusion

Results of the nutritional analyses of 22 Omani date seeds collected from six different regions of the Sultanate of Oman demonstrated that the carbohydrate content was significantly

higher in Seedi date seeds from the Bahla region, energy value was highest in Qush Basrah date seeds collected from the Bahla region, carotenoid contents was highest in Khunaizi date seeds from the Adam region, total flavonoid contents was highest in Qush Basrah date seeds from the Bahla region, total antioxidant content was highest in Handal date seeds from the Bidbid region and dry matter composition highest in Khasab date seeds from the Bahla region. The current investigation showed that all date seed varieties may be considered as a nutritious food source. Moreover these 22 Omani date seeds could play a crucial role as a supplement in human nutrition and health due to their high energy values, dry matter and carbohydrate level. It is interesting to note that Qush Basrah, Seedi, Qush Balquan, and Handal date seeds have significantly higher nutritional attributes. Moreover Fardh, Khasab, Khalas, and Handal date seeds collected from more than one

regions of Oman showed a variation for some nutritional indicators. The authors are of the firm opinion that our evaluation of the 22 leading varieties of date seeds from the Sultanate of Oman could

be employed as either foods or food additives in the manufacturing of inexpensive sources for energy, carbohydrates and dietary fibre.

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