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Physico-chemical characteristics of oil produced from seeds of some date palm cultivars (*Phoenix dactylifera* L.)

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Abstract

The oil content of saturated and unsaturated fatty acids with some physico-chemical properties and nutrients were investigated in oil produced from seeds of six important date palm cultivars and one seed strain present in Saudi Arabia. The results indicated that the oil extracted from six seed cultivars of date palm ranged from 6.73-10.89% w/w oil. The refractive index of date seeds oil was found to be between 1.4574 to 1.4615. The iodine values, acid values and saponification values were in the range of 74.2-86.6 g iodine $100g^{-1}$; 2.50-2.58 mg KOH g^{-1} and 0.206-0.217 mg KOH g^{-1}, respectively. Lauric acid, Myristic acid, Palmitic acid C_{15}, Palmitic acid C_{16}, Stearic acid, Arachidic acid and Behenic acid of date seeds oil contents were found between 8.67- 49.27; 7.01-15.43; 0-0.57; 4.82-18.09; 1.02-7.86; 0-0.08; and 0-0.15 % w/w, in that order. Omega-6 and Omega-9 of date seeds oil were found between 7.31-17.87 and 52.12-58.78%, respectively. Khalas ,Barhy cvs. and seed strain gave highest K and Ca, Na and Fe, Mg as compared with other studied cultivars.

Key words

Date palm, Fatty acid, Nutrients, Physico-chemical properties, Seed oil

Introduction

Date palm is one of the vital horticultural crops in the Kingdom of Saudi Arabia. It ranks at the top among fruit trees as far as numbers (Approx. 24 million trees), area (156023 hr) and production (1008105 tons) (Ministry of Agriculture, 2010) are concerned. It is used as food for humans through history life in arid, tropical and subtropical climatic zone in the world.

Date is composed of a fleshy pericarp and seed. Date pits (known also as date stones, kernels, or seeds) are waste products of many date processing plants producing pitted dates, date powders, date syrup, date juice, chocolate coated dates and date confectionery (Rahman *et al.,* 2007). At present, pits are used mainly for animal feeds in cattle, sheep, camel and poultry industries (Al-Asgah, 1988). An additional function includes roasting date pits and making a caffeine-free drink which can substitute coffee when caffeine is a concern but a coffee-related flavor is desired (Rahman *et al.,* 2007; Al-Qarawi *et al.,* 2005). Such drinks are used in Arabic countries for quite a while. Thus a traditional beverage is obtained by roasting and grinding date seeds in a similar way as for coffee beans. Commercial product (Date Pits Powder- Coffee Substitute) has also been introduced to the market (Rahman *et al.,* 2007). The seed powder is also used in some traditional medicines (Sabah and Mazen, 2007).

Al-Shahib and Marshall (2003) in 14 varieties of date palm, Boukouada and Yousfi, (2009) on Deglet-Nour, Ghars and Tamdjouhert date palm cvs. and Abdalla *et al.* (2012) on ALBarakawi and Alqundeila date palm cultivars have studied Oleic acid in seeds. The literature survey indicates that little work has been carried out on Saudi Arabia's date palm seeds oil to evaluate its physical and chemical characteristics or any other possible potential applications. Date seed oils are naturally

occurring antioxidants and vitamin E (tocopherols). Medically, Vitamin E is a potent antioxidant that protects the body against oxidation reactions (radicals) that damage membranes (Abdalla *et al.,* 2012).

The aim of the present study was to evaluate date palm seed oil and oil quality characteristics in six important selected date palm cultivars, Khalas, Barhy, Khadary, Segae, Succary and Sallag as well as Seeded strain grown in Dirab, Riyadh, Saudi Arabia. In addition, fatty acid composition, important nutrients content and physio-chemical characteristics of oil produced were also assessed.

Materials and Methods

Seeds were collected from six important date palm cultivars: Khalas, Barhy, Kadary, Segae, Succary , Sallag and Seeded strain (Total seven) grown in Research and Agriculture Experimental Station at Dirab, College of Food and Agricultural Sciences, King Saud University, Riyadh, Saudi Arabia.

Oil extraction and preparation : Weight of 800-1000 g of date palm seeds was used for oil extraction. The seeds were manually separated from the fruits and cleaned from flesh and sprayed residuals with tap water and then with distilled water. After washing, they were dried at room temperature for 3 days. Each cultivar seed was ground separately in a hammer mill. Total lipids were extracted from the seeds powder with n-hexane using Soxhlet apparatus. The extraction process was continued for 5 hr. The solvent was evaporated on rotary evaporator under reduced pressure and the oil produced was collected, weighed and stored in a dark container in freezer at 6 ºC for subsequent analyses.

Physico-chemical properties : The refractive index was determined according to AOAC methods (1995). The refractometric value index of seed oil was determined at 20 °C using a digital refractometer ATAGO DR-A1. The colour was determined using Lovibond or Tintometer typed instrument (Tintometer L^{Td} The colour laboratory Salisbury England). The iodine value was estimated using the French norm numbered AFNOR NFT 60-203 (1984). The acid value was determined following the French norm numbered AFNOR NFT 60-204 (1984). The value was evaluated according to the French norm numbered AFNOR NFT 60-206 (1984).

One ml of the seeds oil was added to 7 ml methanolic (0.5M NaoH) followed by 7 ml of methanolic H_2SO_4 before shaking. The solution was left overnight. Two ml of N-hexane was added to the reaction mixture, followed by saturated NaCl. This mixture was shaken well and allowed to separate into two layers. One ml from the upper layer was transferred to a new tube and dried with anhydrous Na_2SO_4. The oil fatty methyl esters were prepared as described in AOAC procedure (1995).

Oil analysis : Analysis, separation, detection and identification were performed using gas chromatography – mass spectrometry (GC-MS) on an Agilent (Palo Alto, CA) 6890N gas chromatograph equipped with an Agilent HP-5MS column (30m x 0.25 mm x 0.25 µm film thickness) and 5973N mass selective detector. The oven temperature was ramped from 60 ºC (2 min) to 320°C (20 min) at a rate of 6 ºC min^{-1}. Persistent organic pollutants (POPs including PAHs) concentrations in filter extracts were determined by GC-MS in the scan (TIC) mode using electron impact (EI). The target analyte list comprised of resolved peaks and was semi-quantitated (% from total). Before analysis, samples were derivatized using TMS by adding 50 l TMS derivatizing agent to 10 l sample after evaporating the solvent under gentle stream of nitrogen, heated for 3 hr, evaporated residual TMS and solvent to dryness and re-dissolved the residues in hexane. 1µl was injected in the GC-MS.

Analysis of nutrient content of oil : Atomic absorption spectroscopy was performed to determine nutrients content of palm seed oil using Shimadzu instrument (AAS – 6800, Japan). For K, Na, Ca, Mg and Fe, content 10 ml oil sample was dissolved in 1 ml carbon tetra chloride (CCL_4). 10 ml^{-1} 10% v/v nitric acid was added to this solution then, mixed well for about 10 min before centrifugation step at 2500-3000 revaluation min^{-1} for 2 min. The supernatant was then separated and the nominated elements were determined by AAS – 6800, with reference to their respective standards (Price, 1979).

Results and Discussion

Regarding the oil extracted from seed date palm cultivars, data demonstrated that, seed oil of Khalas date palm cv. recorded the highest value of oil content (10.89% w/w) followed by Succary (9.87% w/w), Sallag (8.67% w/w), Segae (8.53% w/w), Seeded strain (8.50% w/w) and Kadary cv. (7.81% w/w) while, Barhy cv. gave the lowest value (6.73% w/w) (Table 1). These values were relatively close to the values detected in Deglet-Nour, Ghars and Tamdjouhert date palm cvs. (Boukouada and Yousfi, 2009) and in ALBarakawi and Alqundeila date palm cvs. (Abdalla *et al.,* 2012).

In case of oil colour data presented in Table1 clearly showed that, the color of the produced oils varied from yellowish green to yellow according to cultivar. These results coincide with those obtained by Boukouada and Yousfi (2009). Result of oil refractive index listed in Table 1 showed that values of refractive index ranged between 1.4574 in oil seed of Khalas cv. and 1.4615 in seed oil of Succary cultivar. For instance, Refractive index values were 1.4574, 1.4600, 1.4601 1.4601, 1.4602 and 1.4615 in Khalas, Barhy, Kadary, Segae, Sallag and Succary cvs., respectively and 1.4601 in seed strain (Total seven).

Iodine values of oil from date seeds were between 74.2-86.6 g iodine $100g^{-1}$. Seed oil of Seeded strain gave the highest iodine value (86.6g Iodine $100g^{-1}$). However, the lowest value was detected in seed oil of Succary cv. (74.2g iodine $100g^{-1}$) as shown

Table 1 : Physico-chemical characteristics of oil after its separation from seeds of some important date palm cultivars in Saudi Arabia

Date seeds oils	Cultivars						
	Khalas	Barhy	Kadary	Segae	Succary	Sallag	Seeded strain
Oil extracted % w/w	10.89	6.73	7.81	8.53	9.87	8.67	8.50
Colour	yellow	green	yellow	yellow	Yellowish green	chartreuse	yellow
Refractive Index (20°C)	1.4574	1.4600	1.4601	1.4601	1.4615	1.4602	1.4601
Iodine value (g Iodine $100g^{-1}$)	84.7	85.5	76.7	85.5	74.2	77.6	86.6
Acid value(mg KOH g^{-1})	2.56	2.50	2.54	2.56	2.55	2.57	2.58
Saponification value (mg KOH g^{-1})	214	206	213	215	215	212	217

Table 2 : Fatty acid percent of oil after its separation from the seeds of some important date palm cultivars in Saudi Arabia

No.	R.T	Fatty acid, %		Cultivars							Mean	SD	Min	Max
		Common name	Scientific name	Khalas	Barhy	Kadary	Segae	Succ-ary	Sallag	Seeded strain				
C_{12}	17.708	Lauric acid	Dodecanoic acid	24.17	8.67	14.78	13.85	16.07	19.35	49.27	20.88	13.40	8.67	49.27
C_{14}	21.208	Myristic acid	Tetradecanoic acid	15.43	7.73	7.83	7.01	8.70	9.56	14.67	10.13	3.46	7.01	15.43
C_{15}	22.888	Palmitic acid	Pentadecanoic acid	0.57	ND	ND	ND	ND	ND	ND	0.57	0.00	0.57	0.57
C_{16}	24.474	palmitic acid	Hexadecanoic acid	18.09	7.52	6.80	4.82	5.95	5.20	5.83	7.74	4.65	4.82	18.09
C_{18U}	27.346	Lenolic acid	Octadecenoic acid	17.87	9.38	10.11	7.31	11.07	10.16	9.51	10.77	3.34	7.31	17.87
C_{18}	27.44	Stearic acid	Octadecanoic acid	7.86	3.27	2.31	1.19	1.93	1.22	1.02	2.69	2.41	1.02	7.87
C_{20}	30.855	Arachidic acid	Ecosanoic acid	0.08	ND	ND	ND	ND	ND	ND	0.08	0.00	0.08	0.08
C_{22}	35.729	Behenic acid	Octadec enoic acid	0.15	ND	ND	ND	ND	ND	ND	0.15	0.00	0.15	0.15
			Total	84.22	36.58	41.83	34.178	43.724	45.502	80.291	52.33	1.00	34.18	84.22

ND: Not detected; *SD

in Table 1. The relatively high iodine value in seven oils produced from six date palm cultivars and seed strain may be indicative of the presence of many unsaturated bonds and would certainly contain more unsaturated fatty acids and could be classified as drying oils. Oils are classified into drying, semi drying and non-drying according to their iodine values. Since, the iodine value of date seed oil is lower than 100, it could only be classified as a non drying oil, highly unsaturated oil. The iodine value measure of the unsaturation of fats and oils is expressed in terms of the number of gram of iodine per 100 g sample (El Tome and Yagoub, 2007).

Data listed in Table 1 reflected low acid value in all the six cultivars and seed strain oil, which indicates that these oils contain a small amount of free fatty acids. Decrease in the acid value of extracted date palm oil could be due to small exposure of the seeds to the air during the maturity of the fruits of dates. The low free fatty acid (FFA) content of the oil indicated that it is edible and could have a long shelf life (Boukouada and Yousfi, 2009).

Saponification value of seed strain was 217 mg KOH g^{-1} followed by Segae and Succary cvs. (215 mg KOH g^{-1}). While, Barhy cv. generated a saponification value 206 mg KOH g^{-1}. Akinhanmi *et al.* (2008) determined saponification values for some common oils such as palm oil (196-205 mg KOH g^{-1}), palm kernel oil (247 mg KOH g^{-1}), coconut oil (253 mg KOH g^{-1}), corn oil (187-196 mg KOH g^{-1}) and groundnut oil (188-196 mg KOH g^{-1}). Therefore, the saponification values detected in this study ranged within the same level of some edible oils (Akinhanmi *et al.,* 2008).

The oil was a viscous liquid at an ambient temperature. The fatty acids percentage calculated indicated that, seed strain gave the highest lauric acid content (49.27%), followed by Khalas cv. (24.17%) and Sallag cv. (19.35%). Meanwhile, Barhy cv. gave the lowest lauric acid content (8.67%).

Concerning myristic acid, the obtained results indicated that Khalas cv. gave the highest value of myristic acid (15.43%) followed by seed strain (14.67%). While, Segae cv. produced the lowest content of myristic acid (7%). It is interesting to note that pentadecanoic acid content was not found in the seeds of all cultivars except for the seeds of Khalas cv., where only little amount was contained (0.57%). On the other hand, Khalas cv. gave higher value of palmitic acid (18.09%) followed by Barhy cv. (7.52%) and Kadary cv. (6.80%). However, Segae cv. generated the lowest value of palmitic acid (4.82%). The obtained results indicated that, the highest value of lenolic acid was detected with Khalas cv. seed oil (17.87%) followed by Succary cv. (11.07), Sallag cv. (10.22%) Kadary cv. (10.11%), Barhy cv. (9.38%), seed strain (9.51%) and Segae cv. (7.31%). Concerning steiaric acid, the results in Table 2 indicated that Khalas cv. gave the highest

Table 3 : Nutrients of oil after its separation from seeds of some important date palm cultivars in Saudi Arabia

Date seeds oils	Cultivars						
	Khalas	Barhy	Kadary	Segae	Succary	Sallag	Seeded strain
Nutrients in oil, mg kg^{-1}							
K	604.35	402.7	235.51	235.5	345.5	276.4	337.8
Na	35.75	60.7	57.01	42.1	55.8	45.3	52.4
Mg	0.203	0.167	0.185	0.155	0.165	0.145	0.205
Ca	205.45	201.4	78.50	64.31	88.71	75.4	140.4
Fe	0.28	0.31	0.25	0.20	0.23	0.17	0.30

value of steiaric acid (7.86%) followed by Barhy cv.(3.27%). However, seed strain gave the lowest value of steiaric acid (1.02%). Regarding arachidic acid and behenic acid contents in seed oils of six cvs. and Seeded strain, data in Table 2 showed that Khalas cv. was the only one which contained Arachidic acid and Behenic acid (0.08 and 0.15%), and were not found in other cultivars and seeded strain.

Seed oil palm cvs. of Saudi Arabia can be considered as a good source for many of saturated fatty acids and unsaturated such as lauric acid, myristic acid, pentadecanoic acid, palmitic acid, linolic acid (Omega-6), steiaric acid, arachidic acid and behenic acid. In their study, Akbari *et al.* (2012) reported that seeds contained about 8.5% fat that can serve as a useful source of fatty acids to replace other vegetable oils. Using seeds from three date palm varieties, they obtained the following: peroxide value (1.05), acid value (1.4), p-anisidine value (2.54), Totox (4.64) and refractive index (1.46). Moreover, their results revealed that oleic acid was the primary fatty acid in the all three varieties, followed by lauric, myristic, palmitic, linoleic and stearic acids and trace amounts of other fatty acids like undecylic, capric, nonanoic (pelargonic) and caprylic acids. Similar finding was reported by Besbes *et al.* (2005).

Results obtained from the GC-MS analysis showing the relative concentration of individual estherified fatty acids based on the percent area of each individual fatty acid methyl ester (FAME). The typical GC profile showed the existence of large differences in concentration and distribution of fatty acids in the seven sample seed extract. In fact significant differences were observed for each individual fatty acid of date palm cvs. (Khalas, Barhy, Kadary, Segae, Succary and Sallag and Seeded strain. Lauric acid is the most predominant fatty acids in all samples with a concentration mean of 20.88 ±13.40 % and concentration ranged from 8.67 to 49.27 %. On the other hand as shown in Table 1, linoleic acid (C18:U) or omega-6 and myrestic acid were the second major compound of seeds extract. Linoleic and myristic acid were found at a mean concentration of 10.77% and 10.13 % respectively, and with a range of 7.31-17.87% and 7.01-15.43% respectively. Several authors have analyzed that fatty acid content as a function of stability of oil through temperature, light or oxidation. Gertz *et al.* (2001) showed that oil rich in oleic acid was more stable. The fatty acids in C20 abundance were present in small concentration. Palmitic, arachidic and behenic acid were not detected in all extracts except in extract No 1 with a concentration of 0.57%, 0.08% and 0.15% respectively (Table 2 and Fig. 1).

The results showed that K, Na, Mg, Ca and Fe contents were higher in Khalas cv. (604.35 ppm), Barhy cv. (60.7 ppm), seed strain (0.205 ppm), Khalas cv. (205.45 ppm), and Barhy cv. (0.31 ppm), respectively as compared to other cultivars (Table 3). The present results agree with the results of Abdalla *et al.* (2012), who found a positive relation between seed oil palm cvs. and nutrients composition (Table 3).

The study of lipid profiles of date seed oils may help in their industrial application. These results indicate that date seed oil can be used in cosmetics, pharmaceuticals (Omega-6, Omega-9 and vitamin E). In general, Khalas cv. was the best to give highest oil extracted, fatty acid and nutrients in seed oil followed by seed strain as compared to other cvs. under these conditions.

It can be concluded that date palm seed oil is rich in lauric

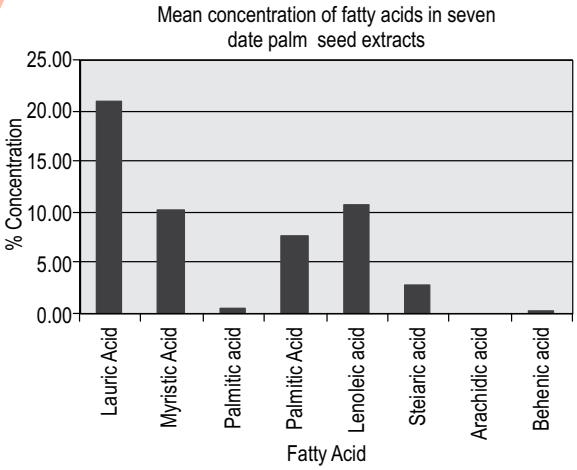

Fig. 1 : Mean concentration of fatty acids in seven date palm seed extracts. -Noteworthy, Palmitic acid (C_{15} and C_{16}).

acid, myristic acid, pentadecanoic acid, palmitic acid, linolic acid (Omega-6), steiaric acid, arachidic acid and behenic acid. Therefore, the studied date palm cultivars of Saudi Arabia can be considered as a very useful source of these saturated fatty acids and unsaturated fatty acids and can replace other vegetable oils. Moreover, these data suggest the potential application of date palm seed oil for cosmetics and pharmaceutical products, as well as healthy food ingredients.

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References

Abdalla, R.S.M., A.A, Albasheer, A.R.M., ELHussein and E.A. Gadkariem: Physico-Chemical characteristics of date seed oil grown in Sudan. *Amer. J. Appl. Sci.,* **9,** 993-999 (2012).

AFNOR: Association Francaise de Normalisation; Recueil de norms francaises des (1984).

Akbari, M., R. Razavizadeh, G.H. Mohebbi and A. Barmak: Oil characteristics and fatty acid profile of seeds from three varieties of date palm (*Phoenix dactylifera*) cultivars in Bushehr-Iran. *Afri. J. Biotechnol.,* **11**, 12088-12093 (2012).

Akinhanmi, T.F., V.N. Atasie and P.O. Akintokun: Chemical composition and physicochemical properties of cashew nut (*Anacardium occidentale*) oil and cashew nut shell liquid, *J. Agri. Food Envir. Sci.,* **2**,1 (2008).

Al-Asgah, N.A.: Date palm seeds as food for carp (*Cyprinus carpio* L.), *J. Coll. Sci.*, King Soud Univ, **19**, 59-64 (1988).

Al-Qarawi, A.A, H. Abdel-Rahman, B.H. Ali, H.M. Mousa and S.A. El-Mougy: The ameliorative effect of dates (*Phoenix dactylifera* L.), on ethanol-induced gastric ulcer in rats, *Mat. Meth. Ethnopharmacol.,* **98**, 313-317. (2005).

Al-Shahib, W. and R.J. Marshall: Fatty acid content of the seeds from 14 varieties of date palm (*Phoenix dactylifera* L.). *Inter. J. Food Sci. Tech.*, **38**, 709-712. (2003).

Association of Official Agricultural Chemists, AOAC: Official Methods of Analysis. A.O.A.C.15th Ed. Published by A.O.A.C. Washington, D.C. (U.S.D) (1995).

Besbes, S., C. Blecker, C. Deroanne, G. Lognay and N.E. Drira: Heating effects on some quality characterization of date seed oil. *Food Chem.,* **91**, 469-476 (2005).

Boukouada, M. and M. Yousfi: Phyto chemical study of date seeds lipids of three fruits (*Phoenix dactylifera* L.) produced in region. *Annales de la des Sciences et Sciences de*.**1,** (2009).

ELTom, O.A.O. and A.E.A. Yagoub: Physicochemical properties of properties of processed peanut (*Arachis hypogaea* L.) Oil in relation to Sudanese standards: A case study in Nyala, South Darfur State, Sudan. *J. Food Tech.,* **5**, 71-76 (2007).

Gertz, C. and S.P. Kochhar: A new method to determine oxidative stability of vegetable fats and oils at simulated frying temperature. Ocl-Ol. Corps Gras Li 8, **1**, 82–88 (2001).

Ministery of Agriculture: Kingdome of Saudi Arabia: Statistical booc.N.1. (2010).

Price, W.J.: Spectrochemical analysis by atomic absorption. Heyden, Philadelphia. 1st Edn., p. 392 (1979).

Rahman, M.S., S. Kasapis, N.S.Z. Al-Marusi, I.M. Al-Marhubi and A.J. Khan: Composition characterisation and thermal transition of date pits powders. *J. Food Eng.,* **80**, 1-10 (2007).

Sabah, A.A.J. and A.N. Mazen: *In vitro* evaluation of the antiviral activity of an extract of date palm (*Phoenix dactylifera* L.) pits on a *Pseudomonas* Phage. e *CAM,* **7**,57-62 (2010).