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CHEMICAL CHARACTERIZATION OF DATE SEEDS (*PHOENIX DACTYLIFERA* L.) CULTIVATED IN ALGERIA FOR ITS APPLICATION AS FUNCTIONAL INGREDIENTS

– Research paper –

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Abstract: Seven date seeds cultivars, Deglet Nour, Degla Baïdha, Fakht, Ghars, Hamraya, Tafezouin and Takermost were provided from Algerian Sahara. Some of these Algerian date seeds were studied for the first time (Fakht, Hamraya and Takermost). The biochemical characterization of these date seeds were studied, including fatty acids and minerals profiles. The results showed that date seeds are a good source of carbohydrates and crude cellulose, with averages of 66.63 and 13.20%, respectively. They are also a good source of proteins, with the cultivar Deglet Nour seeds as the richest one (9.27 ± 0.03%). The main fatty acid for all date seeds oils is oleic acid except for Deglet Nour in which lauric acid is the main one. However, the studied date seed oils could be classified as oleic-lauric oil. Potassium was the highest mineral in all date seeds cultivars, with values ranging from 2700 to 2900 mg/Kg, followed by sodium and iron. These results indicate that date seeds have good nutritional value with different compositions among cultivars. It could be concluded that date seeds could be considered as a good opportunity for their technological and industrial valorization.

Keywords: Date seed; Fatty acids; Mineral profile; Nutritional value, Seed oil

INTRODUCTION

Date palm culture (*Phoenix dactylifera* L.) is the main activity for Algerian Saharan population. In Algeria, the cultivated area has been estimated at 169,380 ha, with an annual date yield production of ten million trees of about 500,000 million tons (Bouguedoura et al., 2015). Over than 900 date cultivars are dispensed throughout different region in the Algerian Sahara, they differ from each other in taste, shape and consistence. The main cultuvars are Deglet Nour, Ghars, Mech Degla, Tafezouin, and Degla Baïdha. These are mainly produced in Biskra, Ouargla and El oued regions. Deglet Nour is the most popular and the most consumed. Otherwise, the other cultivars are processed (Hannachi et al., 1998).

The main products based on date fruits are jam, syrups, vinegar, date powder and date paste. In fact, date fruit seeds are considered as by-products, they are discarded or sometimes used for feeding animals (Mrabet et al., 2020). Despite their high nutritional value, few studies have been conducted on the use of date seeds for the human diet (Bouaziz et al., 2020a).

Date seeds could be valorized for many applications thanks to their high nutritional value. It is mainly composed of a significant amount of

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dietary fiber, carbohydrates, proteins, polyphenols and minerals. Due to these phytochemicals and nutrients, date seeds possess different health promoting properties such as, diabetes and gastrointestinal disorders managnement, antiinflammatory activity, and cholesterol regulation. Their nutritional value in cooperation with a high antioxidant content may reduce risk of many diseases related to oxidative stress (Chandrasekaran and Bahkali, 2013; Platat et al., 2014; Mrabet et al., 2015). Date seeds are considered as a good functional agent for food industry, nutraceuticals, cosmetics and pharmaceuticals (Chandrasekaran and Bahkali, 2013; Reddy et al., 2017). According to Sayas-Barberá et al. (2020), incorporation of date seeds in beef burgers contribute to the improvement of the shelf life, cooking properties, sensory characteristics of burgers and reduce lipid oxidation during storage. Date seeds have also been used to make bakery products, such as bread, muffins and cookies (Ambigaipalan and Shahidi, 2015; Bouaziz et al., 2020b; Najjar et al., 2022).

They are also known as a good source of oil, fat content obtained from several studies ranged from 5 to 13%. Date seeds oil contains vitamins, phenolic compounds, mono- and poly-unsaturated fatty acids (Besbes et al., 2004a; Nehdi et al., 2010; Boussena and Khali, 2016).

Most of date seeds derivated from Algerian cultivars are not characterized. However, further research is needed to establish the nutritional profile of each cultivar to consider their ways of valorization.

The current study was conducted in order to determine the physicochemical and nutrient compositions of seven Algerian date seeds cultivars. The profile of their extracted oils, the minerals compositions were as well investigated.

MATERIALS AND METHODS

Material

Date fruits were collected at maturity (Tamr stage) from El Oued region (33°22’04.12’’N, 6°51’05.94’’E, 600 km from Algiers) for the cultivars Degla Baïdha, Fakht, Ghars, Hamraya, Tafezouin and Takermost and from Biskra region (34°50’41.80’’N, 5°43’29.48’’E, 400 km from Algiers) for the cultivar Deglet Nour.

Date seeds preparation and physical characteristics

All date cultivars were pitted manually. Date seeds obtained were washed with distilled water and air-dried for two to three days. A quantity of three kilograms of each cultivar was used in this study. Date seeds were grinded using a Retsch Muhl grinder and then sifted to obtain a powder of about 0.2 mm of particle size. For the physical characterization, twenty date seeds of each cultivar were taken randomly to determine shape, weight and length.

Physical and chemical analysis

The moisture was estimated by desiccation of 5 g of date seeds powder at 105°C according to AOAC (1997) method. pH and acidity were measured according to the method NFISO1842 (1992), a sample of date seeds powder was placed in a beaker, then a quantity of distilled water (1:10 ; *w*/*v*) was added. The mixture was heated in a water bath at 80°C for 30 min, with a continuous stirring. The mixture was then filtered. pH was measured using HANNA pH-meter. Total acidity was determined by titration with 0.1 N NaOH solution until a persistant pink color appears, using phenolphthalein as color indicator. Carbohydrates were estimated using Dubois et al. (1956) method. Carbohydrates were first extraction using diluted sulphuric acid solution (0.5M). Then, 1 ml of phenol (5%, v/v) and 5 ml of sulfuric acid were added to 500 µl extract. Absorbance was read with a 10 mm path lenght cell at 490 nm after 30 min. Glucose was used as standard. Total ash was determined following AOAC (1995) method by combusting of 5 g of date seeds powder in a muffle furnace (Nabertherm GmBh, Germany) at 550°C. Crude cellulose was measured according to Weende method (NFV03-040, 1993) using a fibertec 1023. Protein amount was determined following Kjeldahl method. One gram of date seeds powder was digested with 25 ml of concentrated sulfuric acid in a Gerhardt Kjeldatherm digestor. The mixture was distilled into boric acid solution (4%, *w*/*v*) using distillation apparatus (Büchi B-324), then titrated with hydrochloric solution (0.25N, *w*/*v*). Protein amount was calculated using a conversion factor of 6.25 (ISO1871, 2009). All experiments were performed in triplicate.

Date seeds calories were estimated for 100 g of the powder. The conversion factors used for fat, protein and carbohydrate were 9, 4 and 4 kcal/g, respectively.

Fat content and fatty acids profiling

Soxhet method was used to determinate fat content. Petroleum ether was used as extraction solvent (ENISO734-1, 2006). The obtained oils were methylated using 5 mL of hexane and 0.2 mL of sodium hydroxide (NaOH) solution (2N) (ISO5508, 1990). After methylation, the fatty acid methyl esters (FAMEs) were analyzed by gas chromatograph coupled to mass spectrophotometry (GC-MS) (Perkin Elmer Turbo Mass Gold Mass Spectrometer) equipped with column (Elit5, 30 m × 0.25 mm, 0.25 µm). Injector and detector temperatures were 220°C and 250°C, respectively. The injection volume was 0.5 µL, and the carried gas was helium at flow rate of 50 mL/min. Oven temperature was 60°C at 0 min, then increased to 230°C at a rate of 2°C/min and it was maintained for 30 min. Date seeds oils fatty acids were identified by comparison of their retention times with standard FAMEs (Sigma-Aldrich, UK) and results are given as relative percentage of the peak areas.

Mineral content

A quantity of 0.5 g of well homogenized date seeds powder is putted in digestion vessel. One milliliter of concentrated hydrochloric acid (HCl) and 5 mL of pure nitric acid were added. Digestion was carried out in microwave digestion system (Multiwave 3000, XQ80 Anton Paar). Mineralization program includes 3 stages: (I) 1 min at irradiation 200 W; (II) 5 min at irradiation 500 W; (III) 15 min at irradiation 1100 W. The samples were transferred quantitatively and 50 mL of bidistilled water were added to each sample. These solutions were used for the determination of mineral content. Perkin Elmer Atomic Absorption Spectrophotometer (AAS) was used to determine mineral content (K, Na, Fe, Zn, Cu, Cr, Ni, Se) and two toxic elements (Cd, As).

Statistical analysis

Statistical analysis was performed using the SPSS software, version 25 (SPSS, 2017). The analysis of the variance (ANOVA) was performed and the differences were considered significant at $p < 0.05$.

RESULTS AND DISCUSSION

Physical and proprieties of date seeds

The physical characteristics of the studied dates seeds were presented in Table 1. Seeds shape is fusiform for Deglet Nour, Fakht, Tafezouin, subcylindrical for Degla Baïdha, Ghars and Hamraya (Figure 1). However, they are ovoid for Takermost seeds. Seeds weight varied between 0.87 ± 0.01 and 1.14 ± 0.03 g. The highest (2.54 ± 0.01 cm) and the lowest (1.53 ± 0.01 cm) date seed lengths were found in Tafezouin and Takermost seeds, respectively (Table 1). The variations of weight and length were determined as significant ($p < 0.05$). These results were similar to those found by Bouaziz et al. (2020a) for the same cultivars.

Chemical composition of date seed

The proximate composition of date seeds studied is illustrated in Table 2. The lowest (10.29%) and the highest (11.65%) moisture were found in Deglet Nour and Takermost seeds, respectively. These results are in agreement with those reported by Nehdi et al. (2010), but lower than those found by Metoui et al. (2019).

Date seeds presented an acidic pH which varied from 5.7 to 6.21. Deglet Nour seeds presented among all the varieties studied the highest amount of ash and protein, which are 2 and 9.27%, respectively. Proteins contents varied from 6.40 to 9.24%, which are higher than the results reported by Besbes et al. (2004a), Nehdi et al. (2010) and Metoui et al. (2019). Furthermore, Rehman et al. (2017) reported that proteins amounts varied among date variety and the cultivated area.

Carbohydrates content varied from 47.98% for Deglet Nour seeds to 72.49% for Takermost seeds. These results are close to those reported by Besbes et al. (2004a) and Bouaziz et al. (2020a). A very low carbohydrates content was found by Metoui et al. (2019) for Tunisian date seeds varieties. These differences may be attributed to the date seeds variety, environmental factors, as well as to the measurements methods.

Hamraya seeds showed the highest fat amount with 13.6%, whereas Degla Baïdha seeds had the lowest content with 9.74%. Referring to different authors, fat content varied according to the cultivar studied from 5.02 to 13.2% (Hamada et al., 2002; Al-Farsi et al., 2007). Degla Baïdha presented the highest crude cellulose. It was monitored that the differences among date seeds in terms of the chemical composition were determined as significant ($p < 0.05$). The energy values of the studied seeds powder varied between 327.26 and 426.24 Kcal/100 g, these results are in agreement with Rehman et al. (2017) who found energy varied from 283 to 407.9 kcal/100 g for Omani date seeds.

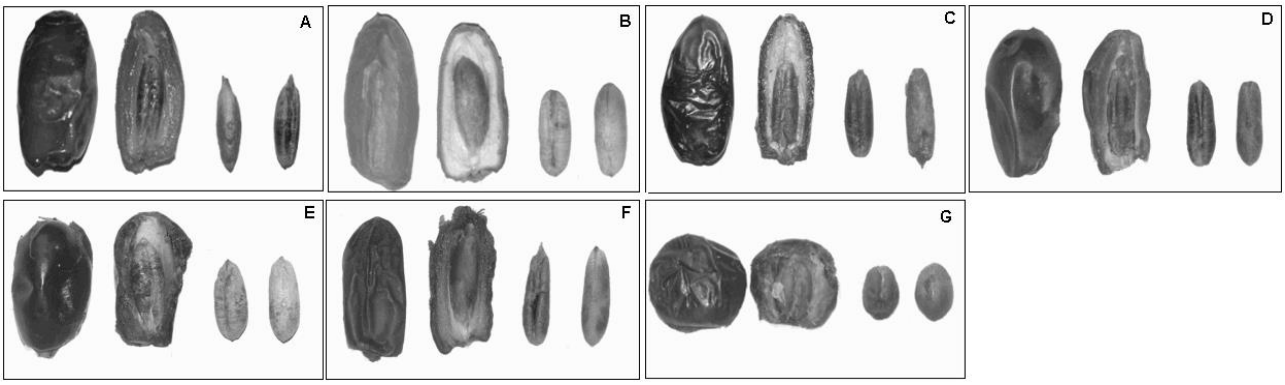


Figure 1. Flesh and Seeds of different date palm cultivars. (A) Deglet Nour, (B) Degla Baïdha, (C) Fakht, (D) Ghars, (E) Hamraya, (F) Tafezouin and (E) Takermost.

Table 1. Physical proprieties of date seeds.

Date cultivar	Shape	Weight (g)	Length (cm)
Deglet Nour	Fusiform	0.87 ± 0.01^{c}	2.52 ± 0.03^{a}
Degla Baïdha	Subcylindrical	$1.06 \pm 0.02^{a,b}$	2.21 ± 0.02^{b}
Fakht	Fusiform	$0.90 \pm 0.01^{b,c}$	2.3 ± 0.02^{b}
Ghars	Subcylindrical	$0.99 \pm 0.03^{b,c}$	2.26 ± 0.06^{b}
Hamraya	Subcylindrical	1.14 ± 0.02^{a}	2.27 ± 0.02^{b}
Tafezouin	Fusiform	0.88 ± 0.01^{c}	2.54 ± 0.01^{a}
Takermost	Ovoid	0.89 ± 0.03^{c}	1.53 ± 0.01^{c}

Values followed by different letters in the same column indicate significant differences ($p < 0.05$).

Table 2. Chemical composition of the date seeds studied.

	Composition of date seeds on g/100g DW							
Date cultivar	Moisture	pH	Ash	Protein	Carbohydrates	Crude cellulose	Fat	Energy value*
DN	10.30 ± 0.02^{a}	5.75 ± 0.12^{a}	2 ± 0.2^{b}	9.27 ± 0.03^{d}	47.98 ± 0.32^{a}	12.37 ± 0.22^{b}	11.59 ± 0.08^{b}	327.24
DB	10.69 ± 0.02^{c}	$6.12 \pm 0.01^{a,b}$	1.35 ± 0.06^{a}	$6.78 \pm 0.52^{a,b}$	$70.94 \pm 0.04^{c,d}$	14.89 ± 0.02^{d}	9.74 ± 0.16^{a}	389.42
FK	10.59 ± 0.02^{b}	$5.94 \pm 0.04^{a,b}$	1.09 ± 0.01^{a}	6.72 ± 0.10^{a}	70.84 ± 0.19^{c}	12.68 ± 0.03^{b}	11.63 ± 0.1^{b}	405.86
GR	10.92 ± 0.01^{d}	6.18 ± 0.04^{b}	1.10 ± 0.03^{a}	6.40 ± 0.2^{a}	$71.11 \pm 0.84^{c,d}$	14.18 ± 0.05^{c}	13.46 ± 0.49^{c}	422.11
HM	11.08 ± 0.01^{e}	$6.06 \pm 0.21^{a,b}$	1.04 ± 0.11^{a}	$7.01 \pm 0.18^{a,b,c}$	$71.23 \pm 0.02^{c,d}$	14.25 ± 0.22^{c}	13.61 ± 0.51^{c}	426.36
TF	11.27 ± 0.04^{f}	$5.90 \pm 0.17^{a,b}$	1.21 ± 0.02^{a}	7.71 ± 0.03^{c}	61.88 ± 0.08^{b}	$12.19 \pm 0.05^{a,b}$	11.48 ± 0.60^{b}	373.85
TK	11.66 ± 0.01^{g}	$6.07 \pm 0.06^{a,b}$	1.20 ± 0.04^{a}	$7.60 \pm 0.07^{b,c}$	72.49 ± 0.56^{d}	11.85 ± 0.14^{a}	$10.37 \pm 0.56^{a,b}$	404.46

* Energy value (Kcal/100g). HM: Hamraya; TF: Tafezouin; DN: Deglet Nour; GR: Ghars; TK: Takermost; FK: Fakht; DB: Degla Baïdha.

Fatty acids profile of date seed oils

All values shown are means of three determinations ± standard deviation (n=3). The different letters in the same column were significantly different ($p < 0.05$). Eight fatty acids are detected in the date seed oils studied (Table 3). The main fatty acid in Fakht, Ghars, Hamraya, Tafezouin and Takermost date seed oils is oleic acid (C18:1), up to 30%, with the highest amount for Fakhet 55.35%. While Deglet Nour seed oil showed the lauric acid (C12:0) as the main fatty acid with 34.03%. In the most of date seed oils, oleic acid is followed by lauric acid (13.30 - 34.03%), then myristic acid (9.55 - 11.91%), palmitic acid (8.47 - 11.70%), linoleic acid (0.4 - 9.97%), stearic acid (1.49 - 4.29%) and finally capric acid (0 - 2.83%). Arachidic acid was detected only in Degla Baïdha seed oil with a small

quantity (0.56%). These findings are close to the results given by Laghouiter et al. (2018) and Ben-Youssef et al. (2017). Otherwise, several minors fatty acids were found by Ibourki et al. (2021) from Moroccan date seed oils. The studied date seed oils could be classified as oleic-lauric oil. Al-Shahib and Marshall (2003) have found that Saudi date seed oils were oleic-lauric to oleic-palmitic types. In another study conducted on nine Algerian date seed oils, six of them were defined as oleic-lauric type (Laghouiter et al., 2018).

Fatty acids composition of date seed oil can change depending on variety, maturity stage and on the method used for extraction (Mrabet et al., 2020). Date seeds oil studied is naturally low in linoleic acid, this advantage made it a good candidate for developing and producing healthy oil. Date seeds oils have an oleic acid amount close to the content found in sesame oil. Moreover, oils rich in oleic acid have high stability and could be introduced in food formulations to substitute *trans* fat (Liu, 2014). The oleic oils are good for manufacturing shelf stable foods because they have a clean flavor and higher oxidative stability which is recommended to have a long product shelf life (Mrabet et al., 2020).

Otherwise, saturated fatty acids in date seed oils varied from 40.06% to 59.88% (Figure 2). It is well known that oils with high saturated fatty acids composition are less sensitive to oxidation. Boussena and Khali (2016) reported saturated and unsaturated fatty acids amounts of 23.51 to 51.75% and 48.24 to 73.03%, respectively. The seed oils that presented the highest amount of mono- and poly-unsaturated fatty acids are Fakht (55.35%) and Deglet Nour (30.96%), respectively. It is widely reported that oil rich in unsaturated fatty acids prevent cardiovascular and inflammatory diseases (Ramadan et al., 2006).

Polyunsaturated to saturated fatty acids ratio varied from 0 to 0.16. The degree of unsaturation of date seed oils is lower than common edible oils, for example, sunflower, sesame and olive oils.

Cluster analysis of fatty acids profiles of dates seed oils and some edible oils revealed four clusters: C1, C2, C3 and C4, as it is shown in Figure 3. Cluster C1 includes dates seed oils which contain a high concentration of oleic and lauric acids. This cluster encompasses all the date seeds oils studied and the oil from *Phoenix canariensis*. Cluster C2 includes peanut, almond and canola oils which contained the highest amount of oleic acid compared with the analyzed oils. Cluster C3 concerned oils rich of linoleic acid including sesame, sunflower, wheat germ, peanut, *Silybum marianum*, pumpkin seed, corn and cotton. Otherwise, cluster C4 includes coconut, tucum, palm kernel and babassu oils which contain higher levels of lauric and myristic acids. In fact, cluster comprised dates seed oils studied is more related to the cluster containing peanut, canola and almond oils.

Table 3. Fatty acids profil of date seeds oils. Values are means ± SD, $n = 3$.

	Fatty acid (%) on seeds oil						
Fatty acids	DN	DB	FK	GR	HM	TF	TK
Capric acid C10:0	2.83 ± 0.22^{d}	0.39 ± 0.06^{b}	0.48 ± 0.03^{b,c}	0^{a}	0^{a}	0.76 ± 0.04^{b,c}	0.81 ± 0.07^{c}
Lauric acid C12:0	34.03 ± 0.56^{e}	13.30 ± 0.28^{a}	17.25 ± 0.47^{b}	26.49 ± 0.29^{d}	36.90 ± 0.08^{f}	32.77 ± 0.51^{e}	21.85 ± 0.27^{c}
Myristic acid C14:0	11.62 ± 0.24^{c,e}	10.17 ± 0.05^{a,b}	11.53 ± 0.33^{c,e}	9.73 ± 0.05^{a,b}	9.55 ± 0.22^{a}	10.68 ± 0.37^{b,c}	11.91 ± 0.28^{e}
Palmitic acid C16:0	9.11 ± 0.02^{a,b}	11.35 ± 0.06^{d}	11.62 ± 0.25^{d}	11.70 ± 0.11^{d}	9.46 ± 0.21^{b}	8.47 ± 0.16^{a}	10.45 ± 0.38^{c}
Oleic acid C18:1	30.96 ± 0.64^{a}	54.95 ± 0.1^{d}	55.35 ± 0.30^{d}	43.86 ± 0.09^{b,c}	38.23 ± 0.15^{a,b}	39.84 ± 0.25^{b,c}	43.87 ± 0.72^{c}
Linoleic acid C18:2	9.97 ± 0.32^{d}	5 ± 0.63^{b}	0.4 ± 0.11^{a}	5.20 ± 0.45^{b,c}	3.94 ± 0.21^{b}	5.66 ± 0.54^{b,c}	7 ± 0.70^{c}
Stearic acid C18:0	1.49 ± 0.19^{a}	4.29 ± 0.06^{c}	3.83 ± 0.20^{b,c}	3.03 ± 0.17^{b}	1.92 ± 0.05^{a}	1.92 ± 0.39^{a}	4.10 ± 0.10^{c}
Arachidic acid C20:0	0^{a}	0,56 ± 0.05^{b}	0^{a}	0^{a}	0^{a}	0^{a}	0^{a}
P/S	0.16	0.12	0	0.10	0.06	0.10	0.14

HM: Hamraya; TF: Tafezouin; DN: Deglet Nour; GR: Ghars; TK: Takermost; FK: Fakht; DB: Degla Baïdha.
Averages, in the same line, with different letters are significantly different using Turkey test ($p < 0.05$).
P/S: Polyunsaturated/saturated fatty acids.

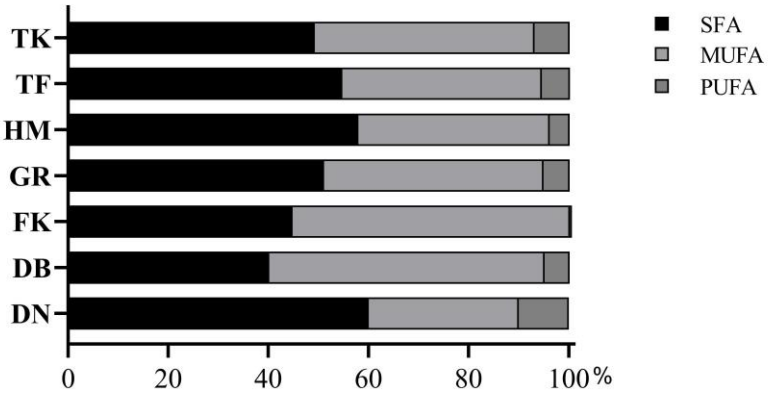


Figure 2. Date seed oils classification according to their saturated (SFA), monounsaturated (MUFA) and polyunsaturated (PUFA) fatty acids. HM: Hamraya; TF: Tafezouin; DN: Deglet Nour; GR: Ghars; TK: Takermost; FK: Fakht; DB: Degla Baïdha.

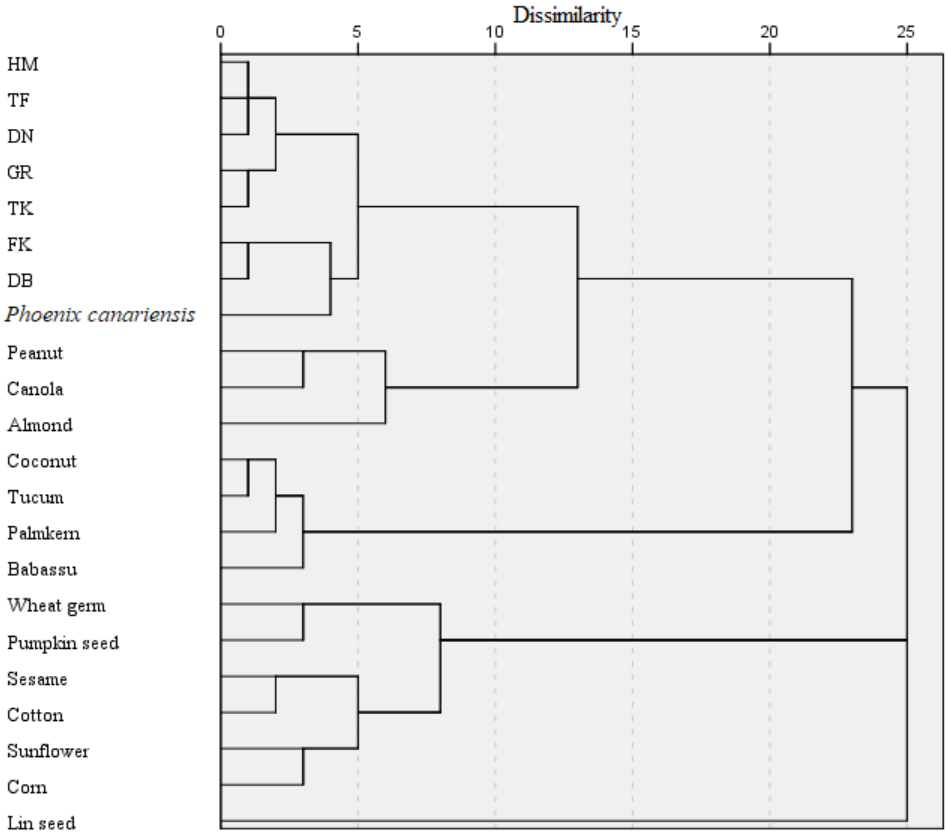


Figure 3. Dendrogram of cluster analysis from the fatty acids of the date seeds studied and several edible oils. HM: Hamraya; TF: Tafezouin; DN: Deglet Nour; GR: Ghars; TK: Takermost; FK: Fakht; DB: Degla Baïdha.

Minerals

Mineral content of date seeds is presented in Table 4. Results showed differences among dates cultivars. In all tested cultivars potassium was the highest mineral, ranging from 2700 to 3000 mg/Kg for Deglet nour and fakht/Degla Baïdha seeds, respectively. Potassium was followed by sodium with levels ranging between 1375 and 2760 mg/Kg, for Fakht and Degla Baïdha seeds, respectively. An exception has occurred for potassium amounts of the studied date seeds which are higher than most of those reported in the literature (Besbes et al., 2004b; Adeosun et al., 2016).

Dates seeds of cultivar Degla Bïdha contain the maximum amount of Na and Fe as compared to the other tested cultivars of dates seeds. Magnesium amount of the studied date seeds ranged between 4.95-7.97 mg/kg, while the chromium levels were in the range of 2.73-9.22 mg/kg. The highest Mg level was determined in Deglet Nour seeds, while

the lowest level was in Degla Bïdha seeds. The lowest copper amount (0.30 mg/kg) was observed in Ghars seeds, and the highest amount was for Takermost seeds (6.23 mg/kg). For the chromium levels, it was recorded that Hamraya seeds showed the lowest content (2.73 mg/kg) while Tafezouin had the highest concentration (9.22 mg/kg). Otherwise, trace elements order were Zn > Cr > Ni > Se. Arsenic was not detected for all date seeds varieties analyzed. However, cadmium is as well under the detection limit except for fakht, tafezouin and Takermost seeds which is detected in small amounts.

It was reported that potassium, phosphorus, calcium, magnesium, and sodium are the abundant minerals in date seeds, while among microelements, iron, magnesium, and copper are found in lower levels (Besbes et al., 2004a; Afiq et al., 2013; Bijami et al., 2020).

Minerals content vary with cultivars, this difference may be due to several environmental factors (climate, temperature, humidity, soil fertility, etc.), agronomical practices and harvest time. In addition, it was reported that ripening stage is another factor affecting mineral profile of date seeds (Shi et al., 2014). According to Bijami et al. (2020) seed mineral concentrations decrease during repining stages to reach the lowest values at maturity (Tamar stage).

In comparison with other natural resources, date seeds have a comparable potassium intake as banana, magnesium as spinach and iron as lentils or liver depending on date seed varieties (Wall, 2006; Valenzuela et al., 2009).s

Table 4. Mineral concentrations (mg/kg dry weight) of date seeds.

	Concentration (mg/Kg dry weight)							
Mineral	DN	DB	FK	GR	HM	TF	TK	RDA mg/day
K	2700	3000	3000	3900	3200	3200	3900	3400
Na	2640	2760	1375	2000	2280	1400	1750	2300
Fe	99.2	172.2	136.1	47.4	34.2	47.9	107.4	8
Zn	< 1.2	8.20	< 1.2	15.9	10.7	< 1.2	< 1.2	11
Mg	7.97	4.95	6.66	7.42	5.82	5.97	6.15	2.3
Cr	4.53	3.04	3.21	3.94	2.73	9.22	3.35	30 µg/day
Cu	1.29	0.53	0.56	0.30	0.77	3.87	6.23	30 µg/day
Ni	2.33	< 0.4	0.5	< 0.4	< 0.4	0.54	1.37	< 1
Se	< 0.04	< 0.04	< 0.04	< 0.04	< 0.04	< 0.04	< 0.04	55 µg/day
As	< 0.75	< 0.75	< 0.75	< 0.75	< 0.75	< 0.75	< 0.75	-
Cd	< 0.05	< 0.05	0.05	< 0.05	< 0.05	0.305	0.11	-

RDA: recommended dietary allowance; HM: Hamraya; TF: Tafezouin; DN: Deglet Nour; GR: Ghars; TK: Takermost; FK: Fakht; DB: Degla Baïdha.

CONCLUSIONS

Most of the date cultivars studied are consumed fresh, with the exception of Degla Baïdha, Ghars and Hamraya, which are mainly processed and used for making confectionary, date powder, sugar,…etc. These cultivars have a low market value, which makes the valuation of their seeds very interesting. All date seeds showed a great nutritional profile, which makes them a potential ingredient for functional food formulation for both human and animal diet. The highest records were presented by DN seeds (proteins, ash, Mg, linoleic acid, PUFA), DB seeds (Cellulose, Na, Fe, strearic acid), FK seeds (oleic acid, MUFA), GR seeds (K, Zn, palmetic acid), HM seeds (lauric acid, fat), TF seeds (Cr) and TK (K, Cu, myristic acid). Interestingly, date seed could be added in small fractions to different flours in order to improve their nutritional quality and reduce price of bread. In addition, Degla Baïdha, Ghars and Hamraya seeds are rich in cellulose which is an advantage to be used in dietetic foods. Date seed oils from all cultivars are rich in oleic acid, known for its high stability and its nutritional importance. However, date seed oil could be considered as edible oil, but its safety should be studied prior to use in human food. Therefore, it is very important to have more research on other date cultivars in Algeria especially those having a low commercial value.

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