

Research Article

Nutritional qualities and fluoride content of different date (*Phoenix dactylifer*) varieties consumed in Morocco

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Abstract

The date is a fruit of the palm family (*Phoenix dactylifer*), grown in Morocco in the southern regions. It is a very important fruit in the Moroccan table, especially during Ramadan (9th month of the Islamic calendar, a lunar calendar consisting of 354 days), where it becomes an essential food that is very nutritious and invigorating to the breaking of the fast added to milk. The present work aimed to determine the contents of mineral elements (fluorine, calcium, magnesium and chlorides) and sugar levels (Brix, glucose) of 12 varieties: Ajwa (Saudi Arabia), Deglet nour (Algeria), Anbara (Saudi Arabia), Anbara (United Arab Emirates), Boufeggous (Errachidia; Morocco), Aziza (Figuig; Morocco), Majhoul (Erfoud; Morocco) Majhoul (Errachidia; Morocco), Elkhalsse (Tafilalt; Morocco) Tarzawa (Tafilalt; Morocco), Deglet nour (Tunisia), Majhoul Sghir (Tafilalt; Morocco) of dates marketed in Morocco of North African and Middle Eastern origin. Fluoride analyses were performed using a fluoride-specific ion electrode (HI-4110). The analyses of Ca, Mg, Cl and glucose levels were performed by Spectrophotometric methods. The results of the fluoride levels revealed in the different varieties of dates varied from 0.26 to 1.05 mg in 100g of fresh weight. The sucrose and glucose levels varied between 11.8 g to 17.75 g and 18 to 40.9 g in 100g of fresh date weight, respectively. The Mg, Ca and Cl levels varied between 46.89 to 93.71mg, 11.20 to 279.28 mg and 30.66 to 47.33 mg in 100g fresh date weight, respectively. Thus, it is possible to classify the varieties of dates on the basis of their nutritional qualities and mode of consumption and to warn the population about their consumption in excess with the risk (if any) of an attack of dental or osseous fluorosis.

Keywords: Dates, Fluoride, Morocco, *Phoenix dactylifer*, Physico chemical, Varieties

INTRODUCTION

Morocco is placed among the top ten world producers of dates, with an estimated 100,000 tonnes in a

favourable year, of which 40% of national production is provided by the Tafilalet region. This fruit plays an economic and social role in the regions of date palm cultivation (Harrak *et al.*, 2010). There are several varieties

of dates in Morocco (Al Majhoul, Elkhalsse, Tarzawa) classified mainly according to their origins, satisfying the tastes of consumers.

The nutritional value of dates is linked to their richness in sugars (glucose, fructose, sucrose, and to a lesser extent, maltose and galactose) with their different proportions in the dry matter according to the varieties (Zhang *et al.*, 2015). These proportions are influenced by the composition of the soil and the degree of maturity of the fruit (Myhara *et al.*, 2000). They contain proteins, lipids, cellulose, mineral salts, vitamins and enzymes. The water content varies from 10 to 40% according to the varieties of dates and according to the regions of production (Harrak *et al.*, 2005). The high mineral content of dates contributes to a balanced diet. The high level of potassium is favorable for the elderly and athletes (whose needs are increased). Dates are the food of choice for sports, especially for long periods. Their calcium, magnesium and iron content is appreciable (Benchelah *et al.*, 2008). Balanced sources of manganese and calcium play an essential role in the health of teeth and bones (Rondanelli *et al.*, 2021).

Dates are full of beneficial compounds such as polyphenols, carotenoids (isoflavones, flavonoids, and lignans), sterols, and tannins, all of which have high antioxidant properties. (Hussain *et al.*, 2020). The polyphenol content decreases with the maturity of the date (Saafi. *et al.*, 2011). Storage for 12 months at -20°C leads to an increase in the polyphenol content and a decrease in the anti-oxidant activity. The glycemic index of dates is variable. Sugar and fiber contents are influenced by different factors, such as variety, soil composition and ripeness of the fruit (Amorós *et al.*, 2009). This dry fruit allows reinforcing very effectively the contribution of fibers, often deficient today in meals. A high-fiber diet helps prevent obesity, type 2 diabetes and

certain cardiometabolic disorders. This fruit has several effects, mainly an antioxidant, anti-cancer, anti-diabetes, anti-inflammatory, anti-tumor and antibacterial potential (Rock *et al.*, 2009, Hussain *et al.*, 2020). Consumption of dates at the end of pregnancy affects uterine contractions and the duration of delivery processes (Kordi *et al.*, 2017).

The date, staple food of many populations, is particularly consumed during the period of Ramadan (9th month of the Islamic calendar, a lunar calendar that consists of 354 days, so its 12 months slowly cycle through different seasons.) with traditions rooted in the regions. In the region of Draa-Tafilalet, the high consumption of dates reaches an average level of 11 kg per capita compared to the rate of 3 kg nationally. In the Sahara region, dates are consumed in large quantities.

MATERIALS AND METHODS

Material

The different varieties of dates were harvested and purchased in the period of June 2021 in the markets of the city of Rabat. The origin and organoleptic qualities (color, size, appearance and taste) of the different date varieties are presented in Table 1.

Methods

Preparation of date juice

A quantity of 40 g of each date pulp was weighed and added to 100 ml of distilled water. After grinding and filtration of the residues, the date juice was recovered and stored in polyethylene bottles.

Determination of nutrients level

Calcium levels were determined by the Cresolphthalein complexon (CPC) method (Moorehead *et al.*,

Table 1. Origin and organoleptic characteristics of date varieties

Varieties	Origin	Color	Size		Aspect	Taste
			Length (cm)	Width (cm)		
Ajwa	Saudi Arabia	Dark brown	3.2	2.4	Soft, very juicy	Very sweet
Deglet nour	Algeria	Brown	4.5	2	Juicy	Sweet
Anbara	Saudi Arabia	Dark brown	3.1	2.1	Soft, very juicy	Very sweet
Anbara	United Arab Emirates	Dark brown	4.1	2.7	Juicy	Very sweet
Boufeggous	Morocco (Errachidia)	Dark brown	4.1	2.7	Dry and soft	Very sweet
Aziza	Morocco (Figuig)	Beige	4	2	Dry and soft	Very sweet
Majhoul	Morocco (Erfoud)	Dark brown	5.2	2.5	Soft, very juicy	Very sweet
Majhoul	Morocco (Errachidia)	Brown orange	3.9	2.4	Juicy	Sweet
Elkhalsse	Morocco (Tafilalt)	Yellow beige	4.1	2	Dry and soft	Little sweet
Tarzawa	Morocco (Tafilalt)	Light beige	3.8	1.9	Dry and hard	Little sweet
Deglet nour	Tunisia	Light brown	4.3	2	Little juicy	Sweet
Majhoul Sghir	Morocco (Tafilalt)	Dark brown	4.4	1.7	Dry and soft	Sweet

1974). This method is based on o-cresolphthalein complexon reagent in an alkaline medium (1 ml), which reacts with the calcium in solutions to form a complex that absorbs at 570 nm after incubation for 5 min at room temperature. The concentration of calcium levels in samples was determined by reference to a calcium standard. Chloride levels were determined by the Colorimetric method (Florence *and* Farrar, 1971; Tietz *et al.*, 1999). This method is based on the reaction of undissociated mercuric thiocyanate to form undissociated mercuric chloride and free thiocyanate ions. Thiocyanate ions react with ferric iron to form a red colored complex whose absorbance was determined at 400-500 nm. The concentration of chloride levels in samples was determined by reference to a chloride standard. Glucose levels were determined by the enzymatic method (Trinder *et al.*, 1969, Farrance *et al.*, 1987). This method is based on the oxidation of glucose by GOD to gluconic acid and H₂O₂ which react in the presence of POD with chloro-4-penome and PAP to form a complex that absorbs at 500 nm after incubation for 10 min at room temperature. The concentration of glucose levels in the samples was determined by reference to a glucose standard. The determination of sucrose was performed by the portable refractometer with Digital display HI 96801 (Brix). Magnesium levels were determined by the Calmagite method (Gindler *et al.*, 1971, Khayam-Bashi *et al.*, 1977). Calmagite forms a complex with magnesium in alkaline medium that is absorbed at 510-550 nm after incubation for 5min at room temperature. The concentration of magnesium levels in the samples was determined by reference to a magnesium standard.

Determination of the fluoride level

The fluoride assay was performed using the potentiometric technique using the fluoride-specific ion electrode (HI-4110) at room temperature. HI-4110 is a combination fluoride ISE ideal for detecting free fluoride in drinking water, soft drinks, wine, plants, emulsified food products and electroplating acids.

RESULTS AND DISCUSSION

Variation in organoleptic qualities of dates

In the present study, the date varieties of Moroccan origin were of varying colors ranging from beige to light and dark brown. The varieties of dates of brown color were soft and very sweet. The dates of Middle Eastern origin had a dark brown color. The dry dates and beige color varieties were not very sweet (Table 1).

Variation in nutrients levels of dates

The sucrose content varied from 11.8% to 17.75% in the different varieties studied. A study conducted by Al-Farsi and Lee (2008) showed that sucrose levels char-

acterized in the different varieties of dates ranged between 0.3% to 8.1% in fresh dates, which remains lower than the value found in our research, and 0.5 to 33.9% in dried dates (Al-Farsi and Lee, 2008). The drying of dates leads to an increase in the sucrose content. The varieties from Morocco had an average [12 800 mg/100g – 14 600 mg/100g] of sucrose content. The variety of Saudi Arabian origin (Ajwa) had a higher content (17 750 mg/100g), while the variety of Algerian origin presented a low content of sucrose (11 800 mg/100g) compared to the other varieties of dates studied. Glucose levels ranged from 18 000 mg/100g to 40 900mg/100g in the different varieties and are comparable to those characterized by Al-Farsi and Lee (2008) [17 600mg/100g – 26 100mg/100g]. The original UAE variety (Anbara) had a higher glucose content (40 900mg/100g) compared to the other varieties. The variety of Moroccan origin (Elkhalisse) had a low content (18 000mg/100g) (Table 2).

Magnesium levels ranged from 46.89 to 93.71 mg in 100 g of fresh weight in the different date varieties. The date variety of Moroccan origin (Elkhalisse) had a higher magnesium content (93.71mg/100g) than the other varieties studied. The variety from Saudi Arabia (Anbara) had a lower value (46.89mg/100g) than the other varieties studied (Table 2). In this study, the rate of magnesium contained in dates was more important than that revealed by Benchelah *et al.* (2008), reporting values between 58 and 68 mg of magnesium per 100 g of pulp. Calcium contents were between 11.20 and 279.28 mg in 100 g of fresh weight in the studied date varieties. The variety from Saudi Arabia (Ajwa) had a high value (279.28mg/100g) compared to the other varieties. The variety of origin Saudi Arabia (Anbara) had a low value (11.20mg/100g) (Table 2). These results were higher than the results of Al-Farsi and Lee [5mg/100g – 57mg/100g] (Al-Farsi and Lee,2008). Calcium was abundant in the different varieties of dates studied and contributed to the calcium intake equivalent to that of cow's milk (Boudon *et al.*, 2013). Chloride contents ranged from 23.19 to 47.33 mg in 100 g of fresh weight in the date varieties studied. The variety of Moroccan origin (Majhoul, Errachidia) presented a higher value (47.33mg/100g) than the other varieties. The variety of Algeria origin (Deglet nour) had a low value (23.19mg/100g) (Table 2).

The results of the mineral composition revealed the richness of the different varieties of dates in mineral elements, calcium, magnesium, chloride and fluoride. The variation in mineral composition among the different date varieties studied could be related to various factors, geographical origin, varietal effect, maturity and harvest time. The work of Hammadi *et al.* (2019) has highlighted the fruits of early maturing cultivars had a high concentration of iron (0.87 mg/100g) and calcium (0.024 g/100g) compared to late maturing cultivars

Table 2. Variation in sucrose, glucose, Mg, Ca, Cl and F content of different date varieties

Date Varieties	Sucrose (mg/ 100g)	Glucose (mg/ 100g)	Mg (mg/ 100g)	Ca (mg/ 100g)	Cl (mg/ 100g)	F (mg/ 100g)
Ajwa	17750	33800	53.34	279.28	34.62	0.63
Deglet nour	11800	34000	65.34	91.47	23.19	0.26
Anbara	12100	32000	46.89	11.20	34.62	1.02
Anbara	13050	40900	61.20	123.45	29.36	0.47
Boufeggous	12800	40200	69.70	14.55	38.16	0.57
Aziza	13350	34000	67.47	196.92	25.19	0.59
Majhoul	14400	31000	68.64	83.43	41.03	0.82
Majhoul	14600	26000	71.68	84.57	47.33	0.69
Elkhalssse	13900	18000	93.71	68.75	38.75	0.49
Tarzawa	14600	25600	65.02	66.65	39.51	0.45
Deglet nour	14200	29800	57.04	56.05	30.66	0.42
Majhoul Sghir	14400	20300	82.02	74.04	39.36	0.57

Standard permissible values: Adults and kids limit: daily free sugar intake to less than 10% of their overall calorie intake; Additional health advantages: would be a further reduction down below 5%, or around 25 grams (6 teaspoons) per day (World Health Organization, 2015); Mg-300 to 350 mg/day for adults (Superior Health Council, 2016); Ca - 800 to 1200 mg/day for adults (D. Ross AC et al., 2011); Cl - 2.3 g (65 mmol)/day for younger adults (National Academies of Sciences, Engineering, and Medicine, 2005) Appropriate intake of fluoride:0.05 mg/kg body weight for all age groups (European Food Safety Authority, 2013)

which had the highest percentage of ash (1.59 g/100g). The work of Tajini *et al.* (2020) revealed the significant difference in mineral composition between the Tunisian variety Deglet Nour and the original variety of Saudi Arabia. Jasim *et al.* (2014) revealed the variation in the chemical composition of dates related to the different stages of maturation. The work of Ben Salah (2006) has highlighted the classification of different varieties of dates according to their mineral composition. The varieties of Maghrebian origin are richer in magnesium and lower in glucose and calcium than the varieties of Middle Eastern origin. The variety of Saudi Arabian origin rich in sucrose has a high level of calcium, while variety 3 (Anbara) had a lower level of sucrose and a low level of calcium.

Variation in fluoride levels

Fluoride levels ranged from 0.26 to 1.02 mg of fluoride in 100 g of fresh date weight. The variety of dates of Algerian origin (Deglet nour) presented the lowest content of fluoride (0.26mg/100g). The variety of origin of Saudi Arabia (Anbara) presented the highest value of fluoride (1.02mg/100g) (Table 2).

The fluoride levels determined in the different date varieties are comparable to those characterized by Zoubeydi *et al.*(2015) in dry date varieties. In the present study, the variety of Saudi Arabian origin had a high level of sucrose, calcium and fluoride. In Ajwa variety the absorption of fluoride could be influenced by the high level of calcium (Villa ,1993). The work of Benmeziane (2019) revealed the variability in the original mineral composition of different dates, with the excep-

tion of Saudi Arabia, where a high fat content characterized the original variety.

The variation of fluoride content in dates could be related to the nature of the soil or irrigation with fluoride-rich water. The climatic conditions, the dry and arid climate, favors the accumulation of salts, especially fluoride, in the groundwater closest to the surface (Zoubeydi *et al.*, 2015). Root uptake of fluoride can lead to its accumulation in the plant tissues as reported for *Camellia sinensis* tea plants containing 1200 to 1900 mg of fluoride/kg of substance (Guimard, 2002). Zobeidi *et al.*, 2015 reported fluoride values ranging from 30.8 to 74.5 mg/kg (3.08 to 7.45 mg in 100 g) fresh weight of the dates. The fluoride contents determined in the different date varieties - Ajwa (Saudi Arabia), Deglet nour (Algeria), Anbara (Saudi Arabia), Anbara (United Arab Emirates), Boufeggous (Errachidia ; Morocco), Aziza (Figuig ; Morocco), Majhoul (Erfoud ; Morocco) Majhoul (Errachidia ; Morocco), Elkhalssse (Tafilalt ; Morocco) Tarzawa (Tafilalt ; Morocco), Deglet nour (Tunisia), Majhoul Sghir (Tafilalt ; Morocco)). were lower than those observed in dry tea leaves (Essebbahi *et al.*, 2020). The level of fluoride accumulated in plants depends on the species, the age of the leaf and the use of fertilizers. The accumulation of fluoride in plants would be secondary to the accumulation of aluminium, and this could play a defensive role. Phosphorus fertilizers contain several contaminants, including F and Cd. The F adsorption increases with an increase in soil pH (Paripurnanda *et al.*, 2008, Diogo *et al.*, 2022). Consumption of fluoride concentrations protects against dental caries in both children and adults (Nasir *et al.*,2015). The risk of fluorosis is when the total con-

sumption of fluoride contained in food exceeds 2 mg for children and 4 mg for adults. According to The European Food Safety Authority (EFSA), the appropriate intake of fluoride is 0.05 mg/kg body weight for all age groups (European Food Safety Authority, 2013) The analyzed samples in the present study, therefore, do not represent a risk of fluorosis with moderate consumption. However, consumption of quantities exceeding 344 g per day for sample three (Anbara (Saudi Arabia)), 421 g per day for sample seven (Majhoul (Erfoud ; Morocco)) may increase the risk of dental fluorosis. All dates analysed for an 8 kg child present a health risk as all values exceed 0.4 mg per 100 g fresh weight, except for sample 2 (Deglet nour (Algeria)), where more than 153 g would be needed to be consumed to exceed the recommended limits. Dates are a source of fluorine in addition to those contained in green and black tea varieties and drinking water (Essebbahi et al., 2020, Essebbahi et al. 2022). With airborne fluoride (World Health Organization 2011), the risk of developing bone fluorosis and the onset of signs of acute fluoride intoxication such as cerebral fluorosis can be achieved (Shashi and Sharma, 2015.) The work described by Messaitfa and Safer (2007) revealed the cumulative sources of fluorine from different foodstuffs such as dates and teas in southern Algeria, predisposing the population to fluorosis. The content of sugars and mineral elements will allow to classify different varieties of dates according to their nutritional composition and guide the consumer towards the choice of the variety. The analysis of the fluoride content of the different dates will allow the population to be warned about the risk of excess fluoride ingestion.

Conclusion

Dates are a balanced source of sugars and minerals and prevent the risk of developing metabolic diseases related to high blood sugar levels. Consumption should be moderate and not exceed the limits recommended by national standards or local guideline. This work makes it possible to classify the various varieties of dates studied according to the rate of sugars and source of magnesium, calcium and fluoride. The physicochemical qualities revealed in the different varieties of dates can be the criteria for the industrial preparation of products from dates.

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Conflict of interest

The authors declare that they have no conflict of interest.

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