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FULL LENGTH ARTICLE

Functional composition and antioxidant activities of eight Moroccan date fruit varieties (*Phoenix dactylifera* L.)

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Abstract The aim of this study was to determine the functional composition and antioxidant activities of eight major date fruit varieties grown in Morocco. The analysis shows that date fruit contains a high amount of sugar (66.03–83.05% DW) but a low content of fat (0.218–0.363% DW) and protein (2.2–3.45% DW). Among the eight studied minerals potassium, calcium and magnesium were the predominant. Moreover, the niacin is the major B vitamin of all analyzed varieties. The total phenolic content was found between 331.86 and 537.07 mg GAE/100 g DW, the flavonoid between 68.88 and 208.53 mg of RE/100 g DW and condensed tannins between 57.56 and 92.141 mg CE/100 g DW, the antioxidant activity ranged between 383.90 and 846.94 μmol TE/100 g DW for ABTS, 6.255 and 2.046 g of date/l for $DPPH_{IC50}$ and 406.614 and 860.89 μmol TE/100 g DW for FRAP assays. The results suggest that date fruit, which is good source of vital nutrients and antioxidant, is an extensive and varied field.

1. Introduction

Date palm is the most important arboricultural crop of the arid regions in Morocco. It has been cultivated for its edible sweet fruit, energy boosters, hunger pacifiers, and its many medicinal properties such as antimutagenic, gastroprotective, hepatoprotective, nephroprotective, immunostimulant and gonadotropic activities (Baliga et al., 2011).

The date fruit contains a wide range of nutritional functional components. It is rich in easily digestible sugars such as glucose and fructose. It represents a good source of fibers

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and traces elements such as potassium, phosphorus, magnesium, calcium, selenium and iron and vitamins such as ascorbic acid, niacin, and pyridoxine. It contains also bioactive components such as anthocyanins, phenolics, carotenoids, procyanidins, and flavonoids which offer protection against oxidative stress (Abdul and Allaith, 2008; Al-Farsi et al., 2005).

Morocco produces yearly more than 113 thousand tones and ranks the thirteenth largest producer in the world (FAOSTAT, 2012). This production is characterized by the predominance of clones from spontaneous natural seedlings named locally "*khalts*" which represent 55.6%. The rest of this production is made up of 223 varieties, each with its own taste and texture (Toutain et al., 1971).

The aim of this study was to enhance the knowledge regarding the compositional and nutritional characteristics of date varieties grown in Morocco, which are the less studied in the date producing countries. This study will shed light on the composition of eight date fruit varieties, considered to be premium quality and the most consumed in Morocco, in terms of the quantity of minerals, vitamins, sugar, protein, fat, phenolic, flavonoid and condensed tannins contents. It will also evaluate their antioxidant activity using three different in vitro assays: DPPH, ABTS and FRAP.

2. Materials and methods

2.1. Plant materials

Eight Moroccan date varieties locally known as *Boufgous*, *Bouskri*, *Bousrdon*, *Bousthammi*, *Bouzgagh*, *Jihl*, *Majhoul* and *Najda* were obtained at Tamr stage from Errachidia National Institute for Agricultural Research. The samples were rinsed, pitted and stored at −20 °C until extraction and analysis.

2.2. Composition analysis

The total nitrogen was determined by the Kjeldahl method (AOAC, 1997) then the Protein amount was calculated using a factor of 6.25. The Lipid was determined from dried date macerated using Soxhlet extraction (AOAC, 1997). The moisture was determined by oven-drying at 105 °C to constant weight (AOAC, 1997).

2.3. Sugar determination by HPLC

The sugar contents (sucrose, glucose and fructose) were determined by liquid chromatography, using the method of Alasalvar et al. (2003) with slight modifications. One gram of each date fruit cultivar was weighed in volumetric flask, and then 100 mL of distilled water was added. The homogenate was then kept in a water bath at 45 °C for 15 min (stirring frequently to aid dissolving sugars). The mixture was filtered through Whatman No. 541 filter paper then filtered again on 0.45 μm membrane filter (Millipore). The equipment consisted of a LC-10AT Shimadzu pump, (HP 1047A) detector, Shimadzu SIL 10ADVP auto sampler, and Shimadzu C-R8A Integrator. The column temperature was set at 30 °C. The mobile phase was acetonitrile/water (75/25, v/v) and the elution was performed at a flow-rate of 1 mL/min. The injection volume was 20 μL. The column was Supelcosil LC-NH 2 (25 × 4.6 mm, 5 μm, Sigma, USA). Identified sugars were quantified based on peak areas compared with a calibration curve obtained with the corresponding standards.

2.4. Determination of energy value

The energy value of the date fruit varieties was calculated based on their content of crude protein, fat and carbohydrate using formula described by Crisan and Sands (1978) as follows:

$$\text{Energy value (kcal/100 g)} = (2.62 \times \%\,\text{protein}) + (8.37 \times \%\,\text{fat}) + (4.2 \times \%\,\text{carbohydrate})$$

2.5. Determination of vitamins content

Niacin (B_3), pyridoxine (B_6) and riboflavin (B_2) were measured according to the HPLC (Moroccan standard 08.1.264). Briefly, 10 g of each date variety was weighed in volumetric flask then 50 mL of Sulfuric acid 0.1 N was added and homogenized for 15 min in room temperature. The mixture was filtered through Whatman No. 541 filter paper then filtered again on 0.45 μm membrane filter (Millipore), and stored at 4 °C until use. The analysis was carried out using a Shimadzu-UFLC Prominence equipped with an auto sampler (Model-SIL 20AC HT), UV–Visible detector (Model-SPD 20A) and Fluorescence Detector (model RF-20A). The HPLC column used was a reversed-phase Hypersil HyPurity C18 (250 × 4.6 mm, 5 μm). The data were recorded using LC solutions software. The mobile phase composition used was 97% octan sulfonic acid buffer (7 mmol/l pH = 3) and 3% acetonitrile (HPLC grade). The analysis was carried out in isocratic mode at a flow rate of 1 ml/min. 20 μL of each samples/standard was injected and monitored at UV 261 for B3 and fluorescence detector for B2 and B6 (λ excitation = 375 nm, 300 nm and λ emission = 400, 525 nm respectively). The standard stock solutions were prepared by dissolving (nicotinamide, pyridoxine hydrochloride and riboflavin) each one alone in hydrochloride acid 0.1 N.

2.6. Determination of ash and mineral contents

The method of AOAC (1997) was employed for the determination of ash and mineral content. Two grams of the pulverized samples was placed in a crucible, ignited in a muffle furnace overnight at 550 °C, Then cooled in a desiccator and weighed at room temperature to get the weight of the ash. To the resulting ash 5 mL of concentrated chloride acid was added, and evaporated on a hot plate; some drops of H_2O_2 and 5 ml of bidistilled water were added and filtered in 100 ml volumetric flasks, then the volume was made up with bidistilled water.

This solution was used for the determination of mineral content. Atomic absorption spectrophotometer (AAS) was used to determine Mg, Fe, Mn, Cu, Ca, K, Na and Zn.

2.7. Preparation of rich polyphenol extracts

The rich phenolic compounds extract was prepared according to the method of Biglari et al. (2008) with slight modifications. Briefly, 30 g of pitted and crushed date fruit was extracted with 150 ml methanol–water (4:1, v/v), at 35 °C for 12 h using an

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