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Adding value to hard date (*Phoenix dactylifera* L.): Compositional, functional and sensory characteristics of date jam

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ABSTRACT

Second-grade dates (with a hard texture) from three potential Tunisian cultivars (Deglet Nour, Allig and Kentichi) showed the same sugar (~73.30–89.55 g/100 g dry matter), fibre (~7.95–18.83 g/100 g dry matter) and total phenolics (~280.6–681.8 mg of GAE/100 g) content as dates of high quality. Deglet Nour and Kentichi varieties were characterised by a high content of sucrose and low reducing sugar content; contrary to Allig and the majority of other date varieties tested. This work intended to add value to these raw materials by using them in jam production. The corresponding jams were characterised in terms of chemical composition, physical (texture and water retention capacities) and sensory properties. Results showed a significant effect of the date variety on the composition and physical characteristics of date jams. Indeed, Allig jam was richer in reducing sugars and was characterised by its higher firmness and water retention capacity. To test the acceptability of these new products, we compared them with quince jam (the most consumed in Tunisia). Results showed that Allig and Kentichi jams presented a higher overall acceptability. However, quince and Deglet Nour jams did not show any significant differences ($P > 0.05$). Results from this work revealed essential information that could promote the commercialization of date jam.

1. Introduction

The date palm tree (*Phoenix dactylifera* L.) is grown extensively in arid and semiarid regions of the world, like northern Africa, the Arabian Peninsula and Iran (Ahmed, Al-Gharibi, Daar, & Kabir, 1995). Date palm constitutes the principal source of remuneration and the basis of economy for the people living in Tunisian Sahara.

The world production of dates has increased considerably during the last 30 years. Indeed, the production has tripled from 2,289,511 tonnes in 1974 to 6,772,068 tonnes in 2004 (FAOSTAT, 2005). Tunisia is currently the 10th world producer and the first exporter of dates in value. During the last five years, Tunisian production has reached an average of 120,000 tonnes per year with dominance of the Deglet Nour variety constituting about 60% of the total production. This variety has a very good sensory quality and a high commercial value. In Tunisia, Deglet Nour, Allig and Kentichi are the most consumed varieties.

This production progress is unfortunately accompanied by a substantial increase of loss during picking, storage, commercialization and conditioning process (Besbes et al., 2005). These lost dates could amount to more than 30,000 tonnes per year in Tunisia and near 2,000,000 tonnes per year globally (Besbes et al., 2004a, 2006). The lost dates, commonly named "date by-products", are not consumed by humans because of inadequate texture (too soft or too hard), contamination with fungus and/or infestation by insects or simply due to their low quality.

Dates having a hard texture are classified in Tunisia as second-grade dates. They are safe for human consumption and may possess high value components such as sugars and fibre that may be used in value-added applications (Besbes et al., 2006; Cheikh-Rouhou, Ben Amara, Besbes, Blecker, & Attia, 2006b; Cheikh-Rouhou et al., 2006a). Presently, very little use is made of these by-products and they are discarded or used in limited cases for animal feed (Besbes et al., 2006). Research into date by-products has not been a true reflection of the importance and potential of this crop.

Jam is one of the most common preserves. In Tunisia, like in the majority of date producing countries, no date jam has been developed for the market. In Tunisia, such dates are used for the manufacture of dough and manufacturers continue to experience difficulties for handling such a product. On the other hand, some studies have been performed on date jam characteristics (Al-Hooti, Sidhu, Al-Otaibi, Al-Ameeri, & Quabazard, 1997). To enhance the date industry, one should begin with a survey of the physico-chemical characteristics of the raw material from the local varieties. Subsequently, laboratory essays may be conducted in order to prepare date products with high added value such as date jam. Knowledge of physico-chemical characteristics of the final

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products is essential for conception and equipment size and process. Sensory evaluation is also important for the selection of the most suitable varieties for making the most appreciated jam by consumers.

This paper reports on value addition to hard dates (second-grade) from the most produced and consumed Tunisian varieties (Deglet Nour, Allig and Kentichi); through characterization of the raw material, date. Then, the study of the physico-chemical properties of jams, traditionally prepared in our laboratories, was considered. This would be helpful to the industry to design new food products, machinery and quality control. Sensory properties of the three prepared jams were evaluated and compared with those of quince jam (the most consumed in Tunisia), in order to test the consumer reaction to these new products.

2. Materials and methods

2.1. Origin of date fruit

This study was conducted on second-grade dates of the most abundant varieties in Tunisia: Deglet Nour, Allig and Kentichi. They were previously sorted and only fruits with texture defect (relatively hard or dry) were kept. These fruits, having the same origin (Degach region, South of Tunisia), were collected at "Tamr stage" (full ripeness). Twenty kilograms from each variety were directly divided into bags of 1 kg and kept at 4 °C until analysed.

2.2. Preparation of date jams

After sorting, the dates were pitted and the fleshes were washed and air dried over eight hours before grinding. The obtained date paste was boiled in water (1:1; w/w) for 15 min. About 540 g of sucrose were added to 1 kg of date paste. Samples were cooked to about 65 Brix in an open kettle, with manual stirring. Soluble solids content (Brix) was determined using an Abbe refractometer (Bellinghan, & Stanley Ltd., Tunbridge Wells, United Kingdom) at 25 °C (AOAC, 1990). The pH was adjusted at the end of cooking to 4.0 ± 0.1 with a citric acid solution (10%; w/v). Then, the jam was poured into glass jars with screw caps and sterilized at 90 °C for 15 min. Samples were immediately cooled to room temperature and stored under different conditions: at 4 °C prior to physico-chemical and sensory analysis and at ambient temperature for colour stability.

2.3. Physico-chemical analysis of dates and jams

Dry matter, protein and ash were determined according to the AOAC (1997) methods. Data were expressed as percentage of dry weight. Total nitrogen was determined by the Kjeldahl method. Protein was calculated using a factor of 6.25. To determine the total ash, samples were ignited and incinerated in a muffle furnace at about 550 °C for 4 h.

Reducing sugars content was determined using the dinitrosalicylic acid (DNS) method (Miller, 1959). Beforehand, the sample was clarified according to AFNOR (1970). Total sugar content was determined by the same method after acid hydrolysis at 100 °C (AFNOR, 1970). Sucrose content was estimated by calculating the difference between the total sugars and the reducing sugars. The toughness index was the ratio between the total sugars content and the water content.

Total dietary fibre content was determined using the enzymatic–gravimetric method of Prosky, Asp, Schweizer, De Vries, and Furda (1988).

Total phenolics content, expressed as gallic acid equivalents (GAE mg/100 g of sample, fresh weight), was determined at 725 nm using Folin-Ciocalteau reagent as described by Al-Farsi, Alasalvar, Morris, Barron, and Shahidi (2005).

The pH was measured at 20° C using a MP 220 pH meter (Mettler-Toledo GmbH, Schwerzenbach, Switzerland).

The water activity of date jam was measured by a NOVASINA a_w Sprint TH-500 apparatus (Novasina, Pfäffikon, Switzerland). The measurement was performed at 25 °C.

Water retention capacities (WRC) of date jams were measured after centrifugation as described by Besbes, Blecker, Attia, Massaux, and Deroanne (2002).

Texture properties of jams were determined by (Texture profile analysis) TPA test. A texture analyser (LLOYD instruments, Fareham, UK) was used to measure the force–time curve for a two-cycle compression. The instrument provides two upward positive (Areas 1 and 2) and two downward negative curves (Areas 3 and 4). Areas 3 and 4 were observed just after the first compression (Area 1) and the second compression (Area 2), respectively. All measurements were carried out in a controlled room at 25 °C. A fixed quantity of jam was placed in a plastic food container to have a constant sample thickness (40 mm). A cylindrical probe (19 mm diameter) was used to compress the sample to a 20 mm depth with a displacement speed of 10 mm/min and a trigger detection force of 0.005 kg. Then, the probe was returned to its original position followed by second "down and up" cycle on the same sample. All operations were automatically controlled by the texture "Nexygen Lot" software connected to the instrument. Texture parameters were calculated from the software. All parameters were measured by the Nexygen MT machine software.

Texture profile parameters were determined as follows: firmness (N) is the peak force of the first compression of the product. Cohesiveness was measured as the area of work during the second compression divided by the area of work during the first compression (Area 2/Area 1). Adhesiveness (N s) is the force required to remove the material that adheres to a specific surface (Area 3). Chewiness (Nmm) is the force needed to masticate the sample for swallowing ([Area 2/Area 1] × Firmness × [Length 2/Length 1]).

Colour was determined after dilution of jam in water (1:3, w/v) and filtration. It was evaluated during the storage of the jams at ambient temperature by measuring the absorbance at 505 nm using a spectrophotometer UV–VIS 1240 (Shimadzu, Kyoto, Japan) (Dervisi, Lamb, & Zabertakis, 2001).

2.4. Sensory evaluation

The samples were presented in a perfectly homogeneous way, i.e. identical conditions of conservation, preparation and presentation. The samples were presented in an anonymous way with a simple coding of three numbers. Jams were evaluated for texture, colour, taste and odour. The mean value of these sensory properties was evaluated as overall acceptability. The samples were evaluated based on a five point hedonic scale, where one represented "disliked extremely" and five represented "liked extremely". Hedonic evaluation was done by an untrained panel consisting of 36 subjects (16 males and 20 females) from the students and the staff members of the National School of Engineer (Sfax, Tunisia). Their ages ranged from 22 to 48 years (mean: 26.0 ± 5.7). Date jams were compared with the most consumed jam in Tunisia (Quince jam), in order to predict the acceptance of the date jam by consumers. Quince jam was purchased from the market and was stored under the same conditions.

2.5. Statistical analysis

Analytical values were determined, using three independent determinations. Values of different parameters were expressed as the mean ± standard deviation ($\bar{x} \pm SD$).