

## **Quantitative and Qualitative Characterization of Native Date Fruits (*Phoenix dactylifera* L.) cv. 'Mejhoul' Related to their Geographical Origins in the Moroccan Oases**

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### **Abstract**

Date palm fruit is well known as a staple human food in many countries with arid and semi-arid climates, notably Morocco. The dates of Mejhoul variety, renowned for the excellence of its market value, were the subject of this study.

Samples harvested at the Tmar stage, from 8 different sites in the Moroccan oases were examined in order to study the variability of date quality as a function of agro climatic conditions, in term of main pomological and physicochemical characterization. On the pomological level, the maximum length of the dates is of the order of  $4.69 \pm 1.11$  cm recorded for the Aoufouss oases while the minimum length is  $3.85 \pm 0.63$  cm obtained for the Tinjdad site. The width oscillates between a maximum of  $2.67 \pm 0.57$  cm recorded for the Zagora dates and a minimum of  $2.24 \pm 0.34$  cm obtained for the Mâadid dates. Moreover, the maximum weight of dates is of the order of  $22.79 \pm 0.57$  g for the Ziz oases, whereas the minimum weight ( $12.41 \pm 0.43$  g) is measured for Tinjdad site. Dates harvested from Ziz oasis are the wettest (40.73%) while those of Aoufouss are the least humid (26.83%). The total mineral matter in the dates is not affected by the sampling site. The obtained values of dietary fiber ranged from 4.76 to 7.22 % NDF/100 g dry matter for date from Ouarzazate and Ziz, respectively.

High Performance Liquid Chromatography (HPLC) was used with REZEX RHM monosaccharide H<sup>+</sup> column and Refractometer as detector. Standard sugars (Glucose, fructose, sucrose and maltose) were spotted using dionized water as solvent. Sugars content was mainly dominated by glucose and fructose, but sucrose and maltose were not detected. Glucose content is higher than that of fructose in the dates of all the geographical origins studied. Ouarzazate dates are the richest in glucose (38.07 g/100 g dry matter), Zagora dates are rich in fructose 36.54 g/ 100 g dry matter, while those of Tinjdad are the least rich in both sugars (glucose: 29.89 g/100 g dry matter and fructose: 26.97 g/ 100 g dry matter). These results can be confirmed the influence of different environmental place, type of the soil and agricultural practices on the contents of these elements in the Moroccan Mejhoul dates.

**Keywords:** Date palm (*Phoenix dactylifera* L.), Date quality, Mejhoul variety, Moroccan Oases, Sugars, HPLC.

## 1. Introduction

In Morocco, actual area occupied by the date palm (*Phoenix dactylifera* L.) is of the order of 71 369 ha, production of dates has increased extensively during the last decade. In fact, the production has tripled from 32 400 tones in 2001 to 125 329 tones in 2016 (FAOSTAT, 2018). Annual consumption of dates is estimated at 2.82 kg per person. However, in more than 68% of cases, this consumption is done on an occasional basis, particularly in the month of Ramadan (Harrak *et al.*, 2001; Harrak *et al.*, 2005). The date is a berry composed of a fleshy pericarp and seed (nucleus) (Besbes *et al.*, 2004). Date palm genetic material is highly diversified, since a lot of cultivated varieties have been studied. Indeed, more than 220 cultivars have been reported, but only 38 of them were studied based on their morphological characteristics and resistance to Fusarium disease (Bendiab *et al.*, 1998).

Dates are rich in carbohydrates, dietary fiber, proteins, certain vitamins, essential fatty acids and minerals (Baliga *et al.*, 2011; Hasnaoui *et al.*, 2011; Vayalil, 2011; Al-Orf *et al.*, 2011 ) Indeed, date is considered to be an important source of rapid energy due to its high sugar content, which varies between 44 and 88% (Al-Shahib and Marshall, 2003). Most of the sugars are mainly glucose and fructose, which are easily absorbable by the human body (Al-Farsi *et al.*, 2007; Mrabet *et al.*, 2008; Borchani *et al.*, 2010) and very small amount of non-reducing sugars (sucrose) (Al-Farsi and Lee, 2008; Rastegar *et al.*, 2012). In fact, sucrose content exceeds glucose and fructose content in the first growth stages, and then sucrose starts to convert into mono-saccharides until sucrose content is less than 5% in the *Tmar* stage. The conversion rate depends on temperature and relative humidity of storage environment in addition to the physiological activities of the fruit (Al-Noimi and Al-Amir, 1980).

Protein content of Moroccan varieties of date oscillates between 1.88 and 4.22 g / 100 g dry matter, Outoukdime variety is characterized by high protein content (Harrak, 1999, Hasnaoui *et al.*, 2011). Relatively, percentage of protein is higher, in comparison with fruit of other species, especially apple, orange, banana and grapes, which contain 0.3%, 0.7%, 1% and 1%, respectively (Al-Showiman, 1998, Al-Shahib and Marshall, 2003). Crude fibers contents of the dates at the end of the maturation process (Stade Tmar) are in the order of 3.6% (Al-Hooti *et al.*, 1997; El-Zoghbi, 1997 and Al-Shahib and Marshall, 2003, Al-Orf *et al.*, 2012).

Phytochemical investigations on dates revealed an important presence of anthocyanins, phenolic compounds, sterols, carotenoids, flavonoids and procyanidins, compounds known to possess multiple beneficial effects (Al-Orf *et al.*, 2012).

Fruits of date palm could have an important all-round role to play in dietary health, so dates offer useful prospects for fighting hunger and diseases (Al-Shahib and Marshall, 2003). In fact, Preclinical studies have shown that the date fruits possess free radical scavenging, antioxidant,

antimutagenic, antimicrobial, anti-inflammatory, gastroprotective, hepatoprotective, nephroprotective, anticancer and immunostimulant activities (Al-Orf *et al.*, 2012).

Tafilalet region is the original cradle of Moroccan Mejhoul variety, known as the "King's date" which has a highly appreciated sensory quality leading to a high marketing value in the world (Pereau-Leroy, 1958). Its culture was introduced in California (USA) since 1980s from Tafilalet oasis and transferred to the Middle East, where it underwent significant quali-quantitative improvements (Chafi *et al.*, 2015).

Marketing of dates on the promising market (European and American) must meet international standards (Chafi *et al.*, 2015). In 2010, United Nations Economic Commission for Europe (UNECE) introduced CEE-ONU DDP-08 Standard on the marketing and quality control of dates, which requires morphological and physico-chemical quality, Including size, water and sugars (reducing and non-reducing), maturity, homogeneity and infestation. Nevertheless, half of Moroccan consumers are interested in the origin of dates (Harrak *et al.*, 2005), which justifies the evaluation of Mejhoul dates and the establishment of a protected geographical indication (PGI) in 2010, called "Mejhoul Dates from Tafilalet" after having developed corresponding Distinctive Signs of Origin and Quality (DSOQ) (Harrak et Boujnah, 2012). Geographical area of the distribution of 'Mejhoul' date palm is estimated at 32 500 km<sup>2</sup>, concentrated mainly in Errachidia province. This delimitation is sufficiently wide to generate a variability of 'Mejhoul' dates including the effect of the microenvironment associated with knowledge farmers.

Some studies have been devoted to the characterization of the main Moroccan date varieties (Harrak, 1999; Harrak *et al.*, 2005; Hasnaoui *et al.*, 2010; Hasnaoui *et al.*, 2011; Taouda *et al.*, 2014; Chafi *et al.*, 2015), with the objectives of evaluating the pomological, physico-chemical, biochemical and biological parameters of dates and classifying them according to specific criteria.

However, very few studies have focused on the evaluation of the variation of parameters indicating the quality of Mejhoul dates according to the geographical origin. The main purpose of this investigation is to evaluate and analyze quality of Majhoul dates from different origins palm plantations in the Tafilalet oases to reach to the promising Moroccan dates.

## 2. Materials and Methods

### 2.1. Plant Material

Samples date palm fruit 'Mejhoul' variety were harvested manually at maturity stage Tmar (September-October, 2015) from eight different geographical sites (Tab.1 and Fig.2): Aoufous, Mâadid, Tinjdad, G'nat, Ziz, Tinghir, Zagora and Ouarzazate, belonging to the area denominated Protected Geographical Indication (PGI). Except for Zagora and Ouarzazate, wich are integrated in this study for comparison.

Fruits were packaged in cardboard boxes and transported to the laboratory, immediately subjected to pomological measurements, then samples were stored at  $4 \pm 1$  °C prior to biochemical analyzes.

**Table 1:** Geographic references of sampled localities for date fruits collection

| Number | Sampled locality | River  | Geographical localization   |
|--------|------------------|--------|---|
| 1      | Aoufous          | Ziz    | Ziz, East of High Atlas   |
| 2      | G'nat            | Gounat | Gounat, East of Jbel Taghouilest Mountains                        |
| 3      | Mâaadid          | Ziz    | Ziz, East of High Atlas   |
| 4      | Ouarzazate       | Dades  | Dades, between the western side of High Atlas and Saghro mountain |
| 5      | Tinghir          | Todgha | Todgha, east of Saghro mountain                                   |
| 6      | Tinjdad          | Todgha | Todgha, east of Saghro mountain                                   |
| 7      | Zagora           | Draa   | Draa, south of Saghro mountain                                    |
| 8      | Ziz              | Ziz    | Ziz, East of High Atlas   |

**Figure1:** Topographic map of Moroccan region indicating sampling geographical origins



## 2.2. Pomological Characterization

### 2.2.1. Fruit, Pulp and Seed Weights

Morphometric measurements were carried out on a composite sample containing 60 fruits from each site. Indeed, the weight of the whole date, pulp and seed was measured using an analytical balance (Denver mark, Germany).

The quality ratios were measured according to the following formulas (Taouda et al., 2014):

$$P/D \text{ ratio (\%)} = \frac{\text{Flesh weight}}{\text{Date weight}} \times 100$$

$$S/D \text{ ratio (\%)} = \frac{\text{Seed weight}}{\text{Date weight}} \times 100$$

### 2.2.2. Fruits Dimension

Fruit length (cm) and fruit width (cm) were measured with a digital calliper (Mitutoyo CD -15GP, Mitutoyo Co., Japan).

## 2.3. Physico-chemical Characterization

### 2.3.1. Dry Matter Content

Dry matter of fruit is determined by evaporation of their moisture without causing volatilization of constituent substances. It was obtained by drying fruits with in an oven (Ehret TK 3064, Germany) at  $102 \pm 3$  °C, for 24 hours and until a constant weight was obtained (Audigie et al., 1984).

The percentage of dry matter is calculated according to the following formula (OECD, 2005):

$$\text{Dry matter} = \frac{(\text{Dry sample weight} - \text{Container weight})}{(\text{Fresh sample weight} - \text{Container weight})} \times 100$$

### 2.3.2. Determination of Ashes

According a modified version of AOAC method 923.03 (1995). Total ashes was determined by incineration of the dry matter, obtained after baking, in a muffle furnace (Volca MC18, France) at 550 °C for 2 hours and ignited to drive off volatile organics.

### 2.4. Qualitative Evaluation

Qualitative evaluation of the results was carried out according to certain classification criteria as proposed by Acourene *et al.* (2001) (Tab.2).

**Table 2:** Qualitative evaluation of dates according to the criteria of some physicochemical and biochemical parameters

| Parameter      | Criteria  | Value        | Qualitative evaluation |
|----------------|-----------|--------------|------------------------|
| Fruit length   | Reeduced  | <3.5 cm      | Bad character          |
|                | Medium    | 3.5 – 4 cm   | Acceptable             |
|                | Long      | >4 cm        | Good                   |
| Fruit weight   | Law       | <6 g         | Bad character          |
|                | Medium    | 6 – 8 g      | Acceptable             |
|                | High      | >8 g         | Good                   |
| Flesh weight   | Law       | <5 g         | Bad character          |
|                | Medium    | 5 – 7 g      | Acceptable             |
|                | High      | >7 g         | Good                   |
| Fruit diameter | Law       | <1.5 cm      | Bad character          |
|                | Medium    | 1.5 – 1.8 cm | Acceptable             |
|                | High      | >1.8 cm      | Good                   |
| Moisture       | Very weak | < 10 %       | Bad character          |
|                | Law       | 10 – 24 %    | Acceptable             |
|                | Medium    | 25 – 30 %    | Good                   |
|                | High      | > 30 %       | Bad character          |
| pH             | Acid pH   | < 5.4        | Bad character          |
|                | Between   | 5.4 – 5.8    | Acceptable             |
|                | Superior  | > 5.8        | Good                   |
| Total sugars   | Law       | 0.5          | Bad character          |
|                | Medium    | 50 – 70 %    | Acceptable             |
|                | High      | > 70 %       | Good                   |

### 2.5. Determination of Individual Sugars by HPLC

#### 2.5.1. Samples Preparation

Analysis of the individual sugar was carried out according to the modified method described by Kafkas *et al.* (2006). Lyophilized flesh fruit is crushed manually using a ceramic mortar. 250 mg is taken for each sample and was dissolved in 25 mL of aqueous ethanol 80% and sonicated for 15 minutes at 80°C, the solvent was filtered by Whitman filter paper using Buchner funnel. The extraction was repeated 3 times by adding 25 ml of ethanol 80%, the filtered extracts are combined and placed in the steam to remove the solvent, the residues are dissolved with 1 mL of deionized water and the pH was adjusted to 9-10 with diluted NaOH (0.1 M). A cartridge of 1 g/6 mL is preliminarily packaged with 6 ml of methanol and 6 ml of deionized water. Then, the recovered sample (1 mL) was eluted slowly through the cartridge and the sugars (neutral compounds) was carried out in solvents twice with 2 mL of deionized water (pH = 7). Finally, the sugars eluted (4 mL) was diluted with filtered distilled water to a final volume of 100 mL. So the sample was prepared for HPLC analysis.

### 2.5.2. HPLC analysis Conditions

An HPLC system (Jasco LC-Net II/ADC, Japan) was used for determination of individual sugar content. The separation was carried out using a REZEX RHM monosaccharide H<sup>+</sup> column with exclusion of ions (300 x 7.80 mm; Phenomenex), contained in an isothermal oven at an adjustable temperature.

The mobile phase consists only of filtered deionized water discharged into the system by a PU-2089 Plus quaternary gradient pump. The HPLC system is connected to an intelligent RI-2031-Plus detector. The flow rate and the injection capacity were adjusted, respectively, to 0.5 mL / min and 20 µL. Separation of sugars from organic acids was carried out by cartridges of 1g/ 6 ml and Chrompure SAX type. The identified sugars were quantified based on peak areas related to two external standards consisting of a mixture of sucrose, maltose, glucose and fructose at concentrations 0.2 and 0.4% each. The baseline was made by a white consisting only of filtered distilled water. The areas of the peaks were determined by the Chrom Nav software and sugar content of each sample was calculated from the corresponding chromatogram, with respect to calibration curve. Results are expressed in g / 100 g dry matter.

The calculation of sugar concentrations was carried out using methods described by several authors (Genna *et al.*, 2008; Piga *et al.*, 2008; Erosy *et al.*, 2003a; Melgarejo *et al.*, 2003; Merguez Bernardez *et al.*, 2004), with certain modifications, as following formula:

$$C = (C1 \times \frac{A}{A1} \times \frac{V}{M}) \times 100$$

Where:

**C:** Sample concentration;

**C1:** Standard concentration;

**A:** Area of peak sample;

**A1:** Area of peak standard;

**V:** Volume of dilution water (100 mL);

**M:** sample weight (0.250 g).

### 2.5.3. Standard Samples

Pure samples (+) Glucose, D (-) Fructose, D (+) Sucrose and D (+) Maltose were used as standard.

### 2.6. Dietary Fiber Content

Dietary fiber fractions of flesh fruit were determined following the procedure of ANKOM Technology, NDF method 13. Dry flesh of dates was crushed with a sieve crusher (diameter 1 mm). 0.5±0.05 g sample were placed in filter bag and weighed, then, a heat seal were used to seal filter bags closed within 4 mm of the top to encapsulate samples.

21 Filter bags were placed in fiber analyzer (ANKOM 200I) with 3 blanks correction (incubated in triplicates), 20 g of sodium sulfite (0.5 g/50 mL of ND solution) and 4.0 mL of heat stable alpha-amylase, were added to 2000 mL of ND solution (30 g sodium lauryl sulfate. USP; 18.61 g Ethylene-diamine-tetra-acetic Disodium Salt. Dihydrate; 6.81 g sodium tetraborate decahydrate; 4.56 g sodium phosphate dibasic anhydrous; and 10.0 mL triethylene glycol, in 1000 mL distilled water). Time of agitation and heating was settled for 75 minutes. Then, 2 washes during 5 minutes were carried out with hot distilled water (85-90 °C) and 4 mL alpha-amylase and the third only by hot distilled water.

All samples were drained and immersed in enough acetone for five minutes, these filter bags samples were dried in an incubator (105 °C; 24 h), placed in a desiccator and weighed after reaching room temperature. Results are expressed in g / 100 g dry matter, fiber residues are mainly hemicelluloses, cellulose and lignin obtained according following formula:

$$a \text{ NDF} = \frac{W3 - (W1 \times C1)}{W2} \times 100$$

Where:

**W1:** Bag tare weight;

**W2:** Sample weight;

**W3:** Weight after extraction process;

**C1:** Blank bag correction (final oven-dried weight/original blank bag weight).

## 2.7. Statistical Analysis

All analytical determinations were performed in triplicate. Values of different parameters were expressed as the mean  $\pm$  standard deviation. Data were subjected to the analysis of variance to study the differences between group means.

To assess for differences in the physical and biochemical characteristics between the oven-drying temperatures, a Student-Newman-Keuls test at 5% level was applied using the Statistical Package for the Social Sciences SPSS (20.0).

## 3. Results and Discussions

### 3.1. Pomological Characteristics and Quantitative Evaluation

Data represent seven pomological variables for dates of eight origins studied (Tab.3). While, results show an interesting variability between samples, the maximum length of date is for Aoufouss origin (over 4.69 cm). This value is close to the figures reported by Chafi *et al.* (2015) for the same 'Mejhoul' variety in Figuig oasis (of the order of 4.68 cm).

For the minimum length, it is recorded for dates from Tinjdad (3.85 cm). As for the width, it ranged between a maximum of 2.67 cm recorded for Zagora dates and a minimum of 2.22 cm obtained for Maadid dates. This range contains the average width (2.97 cm) characteristic of Mejhoul dates as reported by Chafi *et al.* (2015) for Figuig oasis. Except for dates from Maadid and Tinjdad, all the dates studied are considered to be of good character when the dimensions (length and width) are considered. However, dates of these two origins can be qualified as acceptable according to the length as a relative parameter.

The average weight varies between 22.79 g recorded for Ziz dates and 12.41 g found for those of Tinjdad. Ziz and Ouarzazate dates seem to contain more flesh than those of other origins. In addition, Ziz dates have the highest P/D ratio (94.31%). The dates from Mâadid, G'nat and Tinjdad contain the lowest flesh content. The P/D ratio is very interesting as criteria, since it gives an idea of flesh abundance in the whole date and therefore constitutes a commercial characteristic of date appraisal. In comparison with a foreign cultivar such as 'Deglet-Nour', the high-quality date weighing about 10 g contains 10% seed and 90% flesh (Harrak *et al.*, 2012). Values obtained are similar to those reported by Taouda *et al.* (2014) for 'Mejhoul' dates of Figuig oasis which are of the order of 93.5%, but higher than those recorded by Chafi *et al.* (2015) for two moroccan varieties 'Aziza manzou' and 'Afroukhntijant' which have flesh contents of 77.06% and 83.80% respectively. Dates of the eight different origins have a high weight and are therefore of good character when this parameter is taken into account.

Differences between the eight origins could be explained by climatic conditions and cultural practices that are not the same between production locations as well as the metaxenic effects generated by the use of different pollinators.

**Table 3:** Pomological characteristics of 'Mejhoul' dates from different origins

| Origin     | Fruit lenght (cm)  | Fruit width (cm)  | Fruit weight (g)   | Flesh weight (g)   | Seed weight (g)   | Seed/Fruit Ratio (%) | Pulp/ Fruit Ratio (%) |
|------------|--------------------|-------------------|--------------------|--------------------|-------------------|----------------------|-----------------------|
| Aoufous    | 4.69 $\pm$ 1.11 a  | 2.35 $\pm$ 0.24ab | 18.92 $\pm$ 0.57 b | 17.59 $\pm$ 0.56 b | 1.34 $\pm$ 0.03 a | 1.17 $\pm$ 0.25 bcd  | 92.82 $\pm$ 0.25 bcd  |
| G'nat      | 4.01 $\pm$ 0.63 cd | 2.86 $\pm$ 0.57 c | 14.58 $\pm$ 0.79 c | 13.50 $\pm$ 0.79 c | 1.08 $\pm$ 0.02c  | 7.87 $\pm$ 0.50 abc  | 92.13 $\pm$ 0.50 cde  |
| Mâadid     | 3.96 $\pm$ 0.85 cd | 2.24 $\pm$ 0.34 c | 13.31 $\pm$ 0.69 c | 12.22 $\pm$ 0.68 c | 1.09 $\pm$ 0.04c  | 8.53 $\pm$ 0.51 ab   | 91.46 $\pm$ 0.51 de   |
| Ouarzazate | 4.40 $\pm$ 0.43 b  | 2.58 $\pm$ 0.38 a | 21.66 $\pm$ 0.71a  | 20.33 $\pm$ 0.69 a | 1.33 $\pm$ 0.04 a | 6.23 $\pm$ 0.22 de   | 93.76 $\pm$ 0.22 ab   |

| Origin  | Fruit length (cm) | Fruit width (cm) | Fruit weight (g) | Flesh weight (g) | Seed weight (g) | Seed/Fruit Ratio (%) | Pulp/ Fruit Ratio (%) |
|---------|-------------------|------------------|------------------|------------------|-----------------|----------------------|-----------------------|
| Tinghir | 4.39 ± 1.04 b     | 2.43 ± 0.63 b    | 17.97 ± 1.16 b   | 16.63 ± 1.13 b   | 1.33 ± 0.07 a   | 7.67 ± 0.44 abc      | 92.24 ± 0.44 cde      |
| Tinjdad | 3.85 ± 0.63 d     | 2.25 ± 0.32 c    | 12.41 ± 0.43 c   | 11.31 ± 0.42 c   | 1.10 ± 0.02 c   | 8.97 ± 0.28 a        | 91.02 ± 0.28 e        |
| Zagora  | 4.17 ± 0.70 bc    | 2.67 ± 0.34 a    | 18.54 ± 0.74 b   | 17.32 ± 0.74 b   | 1.22 ± 0.05 ab  | 6.78 ± 0.39 cde      | 93.22 ± 0.39 abc      |
| Ziz     | 4.62 ± 0.51 a     | 2.65 ± 0.38 a    | 22.79 ± 0.57 a   | 21.50 ± 0.56 a   | 1.29 ± 0.03 a   | 5.69 ± 0.17 d        | 94.31 ± 0.17 a        |

Average value ± Standard error. Averages with the same letters in the same column are not significantly different at (p = 0.05)

### 3.2. Water Content

The water content of 'Mejhoul' dates varies between a maximum of 40.73% and a minimum of 26.83% (Tab.4). Aoufous dates are the driest and those of Ziz Valley are the most humid, the high moisture content will facilitate spoilage of dates and low moisture content will lead to dry dates not acceptable to consumers (Golshan Tafti and Fooladi, 2006).

In the point of view postharvest, this parameter is interesting for the management of date technology. According to the UN / ECE International Standards DF-08 and the FAO / WHO Codex Alimentarius concerning the marketing of dates, the limit of the moisture content of sugar-reducing varieties is set at 30%. Thus, the dates of Aoufous, Tinjdad and G'nat meet this requirement and can be marketed directly, while those from other origins (Mâadid, Ouarzazate, Tinghir, Zagora and Ziz) require prior drying process before their storage and marketing.

### 3.3. Ash and Organics

Ash content ranged from 0.90 g/100 g dry matter in Ziz dates to 2.59 g/100 g dry matter in Ouarzazate dates. Statistical analysis did not show significant differences ( $P \leq 0.05$ ) in ash and organic content for all samples studied, this result confirm those obtained by Borchani et al. (2010) in the study of Chemical properties of 11 Tunisian date cultivars.

### 3.4. Dietary Fiber

Flesh date contained important amount of minerals. The obtained values ranged from 4.76 to 7.22% NDF/100 g dry matter, respectively, for date from Ouarzazate and Ziz. Compared to other published results, the dietary fiber contents of 14 varieties of date from different countries (Iraq, Iran, Egypt and Saudi Arabia) are as high as 6.4-11.5% depending on the variety of date (Al-Shahib & Marshall, 2003).

Fiber content of studied samples confirms the good nutritional value of 'Mejhoul' dates. Consequently, it can be an ideal ingredient in the human food.

**Table 4:** Moisture, ash, organics and Neutral Detergent Fiber content of Mejhoul dates from studied geographical origins

| Origin     | Moisture %      | Ash %         | Organics       | % NDF/100 g DM |
|------------|-----------------|---------------|----------------|----------------|
| Aoufous    | 26.83 ± 0.43 c  | 1.70 ± 0.09 a | 98.30 ± 0.09 a | 6.09 ± 0.06 ab |
| G'nat      | 31.94 ± 1.33 bc | 1.77 ± 0.17 a | 98.23 ± 0.17 a | 7.15 ± 0.06 a  |
| Mâadid     | 40.48 ± 0.17 a  | 1.58 ± 0.11 a | 98.42 ± 0.11 a | 5.67 ± 0.14 b  |
| Ouarzazate | 36.84 ± 0.53 ab | 2.59 ± 0.08 a | 97.40 ± 0.08 a | 4.76 ± 0.44 b  |
| Tinghir    | 40.73 ± 1.95 a  | 1.34 ± 0.15 a | 98.66 ± 0.15 a | 5.34 ± 0.07 b  |
| Tinjdad    | 31.21 ± 1.83 bc | 1.64 ± 0.01 a | 98.36 ± 0.01 a | 5.58 ± 0.43 b  |
| Zagora     | 29.61 ± 2.99 c  | 1.41 ± 0.11 a | 98.59 ± 0.11 a | 4.97 ± 0.07 b  |
| Ziz        | 28.98 ± 2.09 c  | 0.90 ± 0.12 a | 99.10 ± 0.12 a | 7.22 ± 0.65 a  |

Average value ± Standard error. Averages with the same letters in the same column are not significantly different at (p = 0.05)

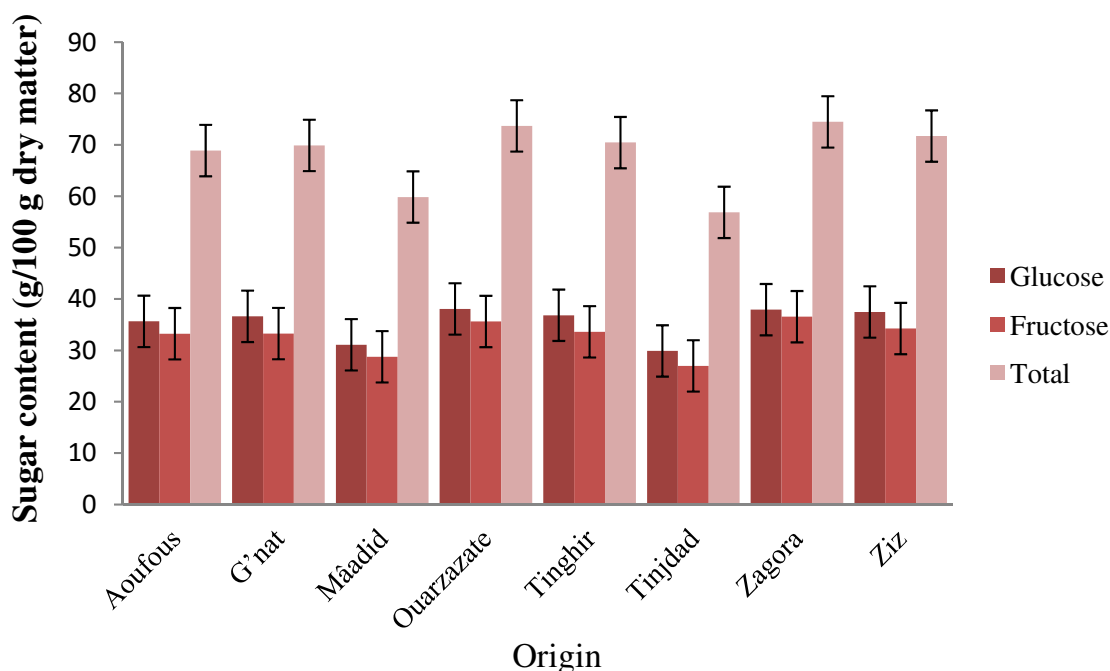
DM: Dry Matter



### 3.5. Individual Sugars

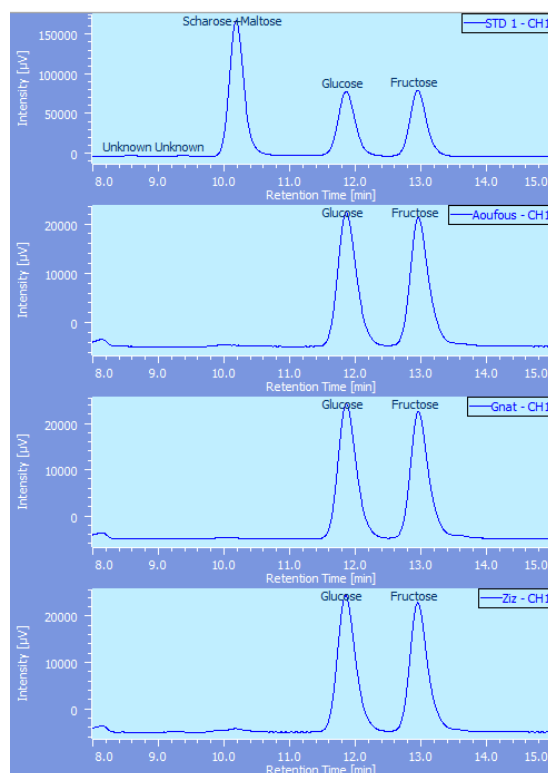
Graph presents the average composition of ‘Mejhoul’ date flesh of the eight studied origins (Fig.2). Total carbohydrate of date flesh samples of the different origins at the “Tamr stage” ranged between 56.86 and 74.47 g/100 g dry matter. Zagora dates had the highest dry matter content whereas dates Tinjdad had the lowest. According to qualitative evaluation of classification criteria as presented by Acourene *et al.* (2001), dates of Aoufous, Mâadid and Tinjdad are qualified acceptable. However, dates of G’nat, Ouarzazate, Tinghir, Zagora and Ziz are qualified good.

**Figure 2:** Individual and total sugars content of ‘Mejhoul’ date flesh from eight studied geographical origins



The sugars contained in the dates ‘Mejhoul’ are only reducing sugars (Fig.3), whereas, sucrose and maltose are not detected. Generally, the content of sucrose dates depends on the variety and stage of fruit development. In this case, the richness of these dates in reducing sugars and the absence of sucrose suggests the existence of a more pronounced invertase activity at Tam stage, which would considerably reduce its content in sucrose or through the non-enzymatic reactions of browning Storage (Maillard reactions) (Barreveld, 1993; Elleuch *et al.*, 2008; Besbes *et al.*, 2009; Amira *et al.*, 2011), our results are in agreement with recent previous reports on Tunisian dates (Borchani *et al.*, 2010; Amira *et al.*, 2011), Iranian dates (Rastegar *et al.*, 2012) and Pakistan dates (Haider *et al.*, 2014).

**Figure 3:** HPLC chromatograms for standard (STD1) and dates from three origins (Aoufous, G'nat and Tinjdad)



As expected, glucose content is higher than that of fructose in the dates of all the geographical origins studied. Ouarzazate dates are the richest in glucose (38.07 g/ 100 g dry matter), Zagora dates are rich in fructose 36.54 g/ 100 g dry matter, while those of Tinjdad are the least rich in both sugars (glucose: 29.89 g/ 100 g dry matter and fructose: 26.97 g/ 100 g dry matter). Consequently, sugar content of 'Mejhouli' dates changes considerably depending on the geographical origins characterized by different soils and climatic conditions during their life on the palm.

#### 4. Conclusion

In our knowledge, this is the first study presenting comprehensive data on 'Mejhouli' dates in Moroccan oases. A laboratory analysis was carried out to study some pomological characteristics and biochemical proprieties of Moroccan 'Mejhouli' date from different origins in Tafilalet Oases.

Results revealed a significant difference between fruit dates of geographical origins of the harvest, indicating a significant variability in the date richness of this variety, at the morphometric level, caliber of dates either by size or by the unit weight of dates were evaluated, this parameter exceeded 4 g value set as the minimum weight by UNECE Standard DDP-08 (2010) with a very high pulp content, which exceeded 91% in all origins studied.

As for the biochemical analyzes, they revealed a high glucose content (29.89-38.07 g / 100 g dry matter) and fructose (26.97-36.54 g / 100 g dry matter) of all the localities studied.

Dates of Maadid. Tinghir. Ouarzazate. Zagora and Ziz are relatively wet (% moisture  $\geq 30\%$ ) and therefore require drying treatment before marketing. Thus, results obtained can serve as a database to be exploited with the aim of improving the storage and packaging technology of 'Mejhouli' according to their origin. Also, it can be a powerful tool to establish a new specific map of the land related to characteristics of 'Mejhouli' dates in Morocco.

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