

MORPHOMETRIC AND BIOCHEMICAL CHARACTERISTICS OF DATE FRUITS FROM TEN INDIGENOUS DATE CULTIVARS IN THE OUARGLA VALLEY (ALGERIAN SAHARA)

DEROUICHE Rima^{1,2,3}, BABAHANI Souad^{2,3}, KEMASSI Abdellah^{1,4*}

⁽¹⁾Laboratory of Mathematics and Applied Sciences, Faculty of Natural and Life and Earth Sciences, Department of Biology, University of Ghardaia, 47000, Algeria

⁽²⁾Laboratory of Saharan Bio Resources, Faculty of Natural and Life Sciences, Department of Agronomic Sciences, University of Kasdi Merbah Ouargla, 30000 Ouargla, Algeria

⁽³⁾Laboratory of Research on Phoeniculture, University of Kasdi Merbah Ouargla 30000 Ouargla, Algeria

⁽⁴⁾Laboratory of Arid and Semi Arid Zones Ecosystems, University of Kasdi Merbah 30000 Ouargla, Algeria

*E-mail: akemassi@yahoo.fr

(Received 12 June 2019 - Accepted 26 June 2019)

Abstract.-The Algerian production of dates is around 900,000 tons every year. This production is mainly consumed fresh, the rest or even sometimes the rejects can be transformed by traditional or technological processes into date paste, date flour, baker's yeast, alcohol, vinegar, and other by-products. The objective of this study is to characterize the morphometric and biochemical properties of ten indigenous date cultivars for showing their potential uses. The water content was obtained by oven drying, the ash content was determined by incineration in the muffle furnace, and sugar was determined by the Lane-Eynon method. Morphological examinations revealed the existence of differences between cultivars; mainly honey color and soft consistency. The size of dates vary between 3.09 cm to 4.9 cm in length and 1.76 cm to 2.41 cm in width, and their weight varies between 4.01 g and 12.77 g. The physico-chemical and biochemical analysis showed an acidic and slightly acidic pH, a water content ranging from 18.3 % to 39.5 %, an ash content ranging from 1.25 % to 3.33 %, and total sugar content between 51.11 % and 65.04 %. So, these cultivars have acceptable potentialities to be valorized by technological means.

Keywords: Indigenous date cultivars, date, biochemistry, technology, Algerian Sahara.

CARACTÉRISTIQUES MORPHOMÉTRIQUES ET BIOCHIMIQUES DES FRUITS DE DIX CULTIVARS DE DATE LOCAL DANS LA VALLÉE D'OUARGLA (SAHARA ALGÉRIEN)

Résumé.- La production algérienne de dattes est d'environ 900 000 tonnes chaque année. Cette production est principalement consommée fraîche, le reste ou même parfois les rebuts peuvent être transformés par des procédés traditionnels ou technologiques en pâte de dattes, farine de dattes, levure de boulanger, alcool, vinaigre, et autres sous-produits. L'objectif de cette étude est de caractériser les propriétés morphométriques et biochimiques de dix cultivars de dattes local pour montrer leurs utilisations potentielles. La teneur en eau a été obtenue par séchage dans l'étuve, la teneur en cendres a été déterminée par incinération dans le four à moufle et le sucre a été déterminé par la méthode Lane-Eynon. Les examens morphologiques montre l'existence des différences entre les cultivars; principalement couleur miel et consistance douce. La taille des dattes varie entre 3,09 cm et 4,9 cm de longueur et 1,76 cm à 2,41 cm de largeur, et le poids varie entre 4,01 g et 12,77 g. L'analyse physico-chimique et biochimique a montré un pH acide et légèrement acide, la teneur en eau allant de 18,3% à 39,5%, la teneur en cendres varie de 1,25% à 3,33%, et des teneurs en sucres de 51,11% à 65,04%. Les cultivars ont des potentialités acceptables pour être valorisées par des moyens technologiques.

Mots clés: cultivars de dattes locales, datte, biochimie, technologie, Sahara algérien.

Introduction

Algeria is one of the main date producing countries; it is ranked second after Egypt, with a production of 1058559 tonnes in 2017 [1]. This country is known for the richness of its phoenicultural heritage: more than 900 cultivars identified [2]. Although the market is oriented only towards few cultivars, where there are about ten cultivars with high market value, which are 1,06 % of cultivars. Generally, the so-called common dates have a low market value, a large part of which used to feed animals. Whereas this type of date fruits can valorised by biotechnological processes of transformation into different food products. Indeed, date-based products are numerous and diverse, including date sugar, date pasta, juices, syrups, carbonated drinks, confectionery, pastry, cookies, etc. In addition, the richness of these dates with sugars, offers possibilities to prepare many products with high added value such as ethanol, baker's yeast, citric acid, lactic acid, etc.

Therefore, aimed to characterize the morphometric, physico-chemical, and biochemical proprieties of some date cultivars in order to suggest ideas of their development.

1.- Material and methods

1.1.- Raw material

Ten varieties common dates were harvested at the Tmar stage from Ouargla valley. These cultivars are Reguiga, Sbaa-Wa-Draa, Tinicine, Ammari, Dguel Merigh, Dguel Djebbar, Talessasset, Tchibbi, Taweddane and Bayd El Hmam. The chosen cultivars are moderately rare and their date fruits are of low market value. Date fruits were collected from different regimes for homogeneity.

1.2.- Methods

The characteristics of a random sample of 10 fruits at the Tmar stage of each cultivar were determined [3]. For morphometric proprieties, the lengths and diameters of date fruits were measured using a caliper. Also, the fruits were weighed and weight ratio pulp/date was calculated. Then the colour, shape, and consistency were determined. For physico-chemical proprieties, the pH was determined using the pH meter and the water content was determined. Five grammes of each sample were dried in an isothermal oven at $103 \pm 2^\circ\text{C}$ until a constant mass of the sample was obtained. The water content is equal to the lost mass. Finally, date fruits pulp was incinerated in a muffle furnace at 550°C to determine the ash weight [4]. The reducing sugars and the total sugars were determined by the Lane-Eynon method. The sucrose content was obtained with the following formula:

$$\text{Sucrose (\%)} = [\text{Total sugars (\%)} - \text{Reducing sugars (\%)}] \times 0.95 \text{ [5]}$$

Valorization methods were suggested based on the found proprieties and the following literature: MUNIER (1973) [6], OUELD EL HADJ *et al* (2001) [7], ARFA (2008) [8], MIMOUNI and SIBOUKEUR (2011) [9], KAIDI and TOUZI (2001) [10], JEMNI and MEJRI (2006) [11], BOURGOIS and LAEPENT (1995) [12], FERRY *et al* (1999) [13].

2.- Results

2.1.- Morphological and biometric characteristics of date fruits

2.1.1.- Morphological characteristics of date fruits

In regard of the date shape, the majority of cultivars are sub-cylindrical except Tchibbi and Bayd El Hmam, which are ovoid and sub-spherical respectively. Ninety percent of cultivars are dark. Reguiga, Tchibbi, Taweddanet, and Bayd El Hmam colour is honey. Sbaa-wa-Draa, Tinicine, and Dguel Merigh are dark brown. Ammari and Talessasset are black. However, Dguel Djebbar is yellow. Most of the cultivars have a soft consistency. Ammari and Tchibbi have a semi-soft consistency but Dguel Djebbar has a dry consistency (tab. I).

2.1.2.-Biometric characters of date fruits

The Sbaa-wa-Draa and Tinicine date fruits are the longest ones with 4,9 cm long, while the shortest one is *Ammari* date fruits with $3,06 \pm 0,1$ cm long. In regard of diameters, *Bayd El Hmam* is the widest date fruit with $2,41 \pm 0,1$ cm wide. However, *Ammari* is only $1,76 \pm 0,07$ cm wide (fig. 1 and 3).

Table I.- Morphological characteristics of date fruits from ten date varieties harvested from the valley of Ouargla.

Cultivars	Morphological characteristics of date fruits		
	Shape	Color	Consistency
<i>Reguiga</i>	Sub-cylindrical	Honey	Semi-soft
<i>Sbaa-wa-Draa</i>	Sub-cylindrical	Dark brown	Soft
<i>Tinicine</i>	Sub-cylindrical	Dark brown	Soft
<i>Ammari</i>	Sub-cylindrical	Black	Semi-soft
<i>Dguel Merigh</i>	Sub-cylindrical	Dark brown	Soft
<i>Dguel Djebbar</i>	Sub-cylindrical	Yellow	Dried
<i>Talessasset</i>	Sub-cylindrical	Noire	Soft
<i>Tchibbi</i>	Ovoid	Honey	Soft
<i>Taweddanet</i>	Sub-cylindrical	Honey	Soft
<i>Bayd El Hmam</i>	Sub-cylindrical	Honey	Soft

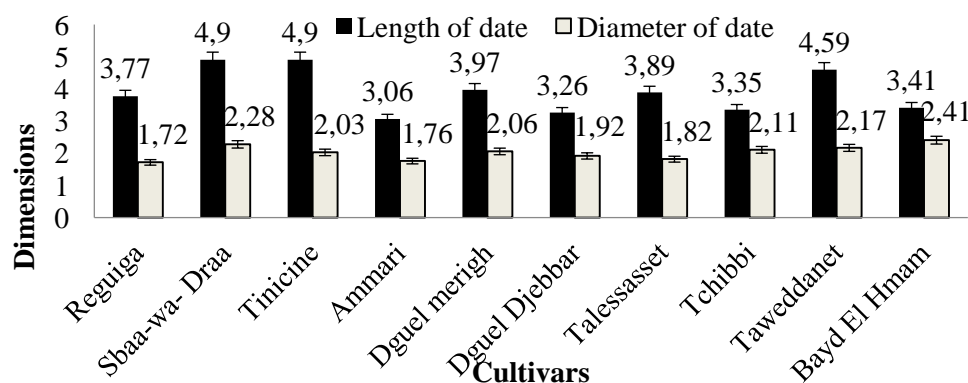


Figure 1.- Length and width of date fruits from ten date varieties harvested from Ouargla valley

The length over diameter coefficient (L/D) is a parameter used to evaluate dates quality. Tinicine is 2,41 and has the highest L/D (fig. 1 and 2). However, *Bayd El Hmam* is 1,41 and has the lowest L/D (fig. 2).

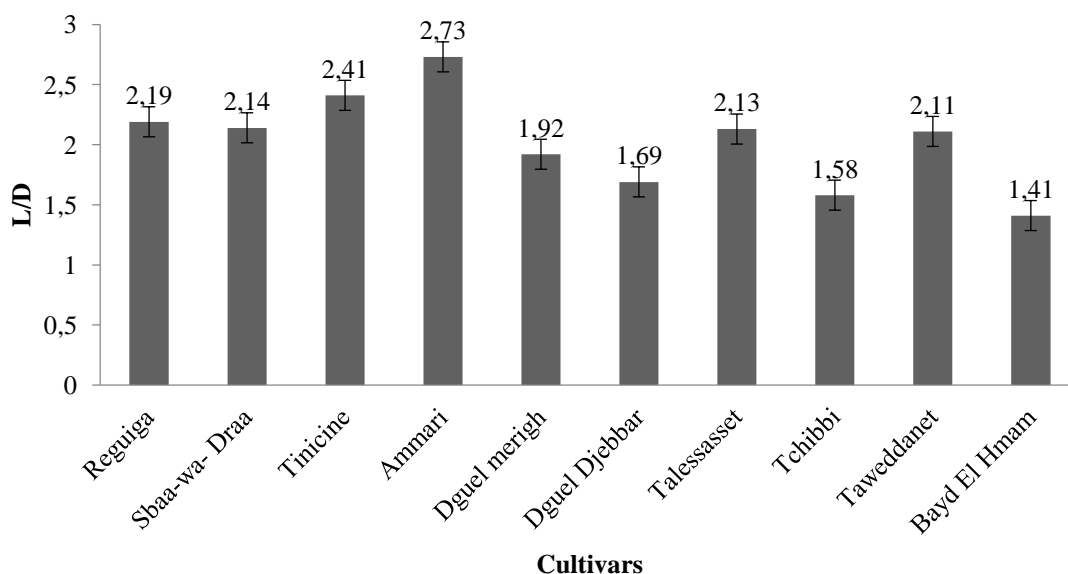


Figure 2.- Length/Diameter ratio of date fruits from ten date varieties harvested in Ouargla valley

The lowest weights are those of date fruit and pulp of *Ammari* cultivar, which are $4,01 \pm 0,6$ g and $2,82 \pm 1,05$ g; respectively, however, the highest are obtained with the date fruit and pulp of *Tawedd Janet* cultivar that are about $12,77 \pm 1,06$ g and $11,48 \pm 0,97$ g, respectively.

Table II.- Weight of the date fruits and pulp from ten date cultivar harvested in Ouargla valley

Cultivars	Date weight (g)	Weight of pulp (g)	Pulp / Date Ratio (%)
<i>Reguiga</i>	$5,55 \pm 0,66$	$4,43 \pm 0,61$	79,85
<i>Sbaa-wa-Draa</i>	$11,58 \pm 1,56$	$10,46 \pm 1,43$	90,31
<i>Tinicine</i>	$9,08 \pm 1,27$	$7,99 \pm 1,27$	87,93
<i>Ammari</i>	$4,01 \pm 0,63$	$2,82 \pm 1,05$	70,28
<i>Dguel Merigh</i>	$8,08 \pm 1,13$	$7,27 \pm 0,9$	90,08
<i>Dguel Djebbar</i>	$6,85 \pm 0,38$	$5,82 \pm 0,99$	84,95
<i>Talessasset</i>	$7,12 \pm 0,84$	$8,71 \pm 0,81$	80,31
<i>Tchibbi</i>	$8,59 \pm 0,45$	$7,62 \pm 0,44$	88,68
<i>Tawedd Janet</i>	$12,77 \pm 1,06$	$11,48 \pm 0,97$	89,9
<i>Bayd El Hmam</i>	$8,40 \pm 0,91$	$7,4 \pm 0,83$	88,09

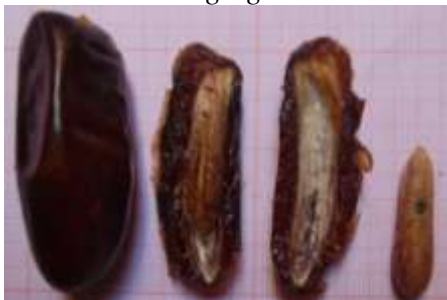
g: gram



Reguiga



Sbaa-wa-Draa



Tinicine



Ammari



Talessasset



Dguel Merigh



Dguel Djebbar



Tchibbi



Bayd Elhmam



Taweddanet

Figure 3.- Colours and shapes of date fruits from ten date varieties harvested in the valley of Ouargla

2.1.2.- Physico-chemical characteristics

The pH is one of the parameters determining the ability to preserve food. It ranges from 5,54 to 6,5 in date fruits from the studied cultivars (tab. III). The water content, on the other hand, ranges from 39,5% in *Tinicine* to 18,3% in *Ammari* (fig. 4).

Table III.- Average pH of date fruits from ten date varieties harvested in the valley of Ouargla

Cultivars	pH
<i>Reguiga</i>	5,2 ± 0,06
<i>Sbaa-wa-Draa</i>	5,93 ± 0,03
<i>Tinicine</i>	6,17 ± 0,19
<i>Ammari</i>	5,92 ± 0,1
<i>Dguel Merigh</i>	5,97 ± 0,19
<i>Dguel Djebbar</i>	5,54 ± 0,04
<i>Talessasset</i>	5,92 ± 0,05
<i>Tchibbi</i>	6,03 ± 0,18
<i>Taweddanet</i>	6,27 ± 0,17
<i>Bayd Elhmam</i>	6,5 ± 0,02

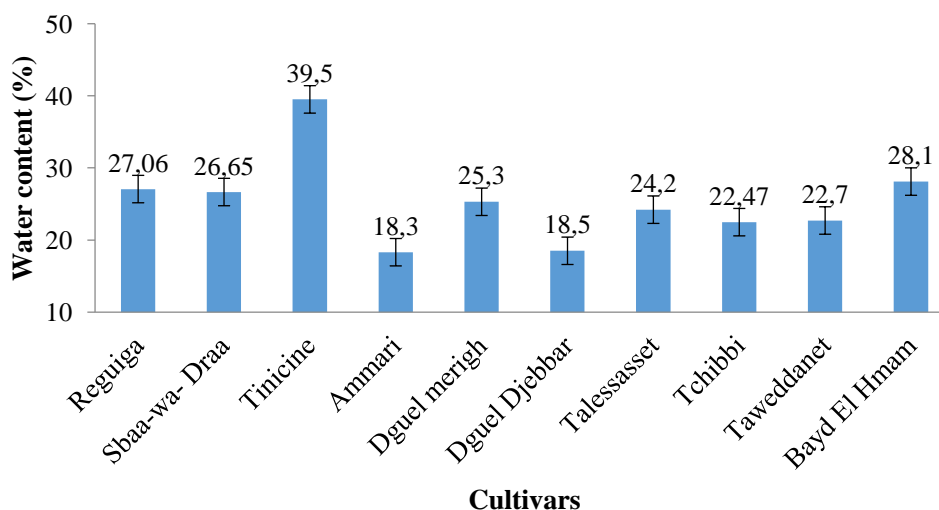


Figure 4.- Water content of date fruits from ten date cultivar harvested in the valley of Ouargla

The ash rate represents the total amount of mineral salts present in the fruit. The ash rates of the analysed date fruits range from 1,25% to 3,33% (fig. 4).

2.2.- Biochemical characterization

The quantitative analysis of sugars (fig. 5) shows that the total sugar contents vary between 51,11% in date fruits of *Bayd El Hmam* cultivar and up to 65,04% in date fruits of *Tchibbi* cultivar. Total sugars are sucrose and reducing sugars. The sucrose is present in very low quantities in date fruits of all studied date cultivars as opposed to reducing sugars. The sucrose content in all cultivars is less than 5%, but reducing sugars extend between 50,3% and 64,5%.

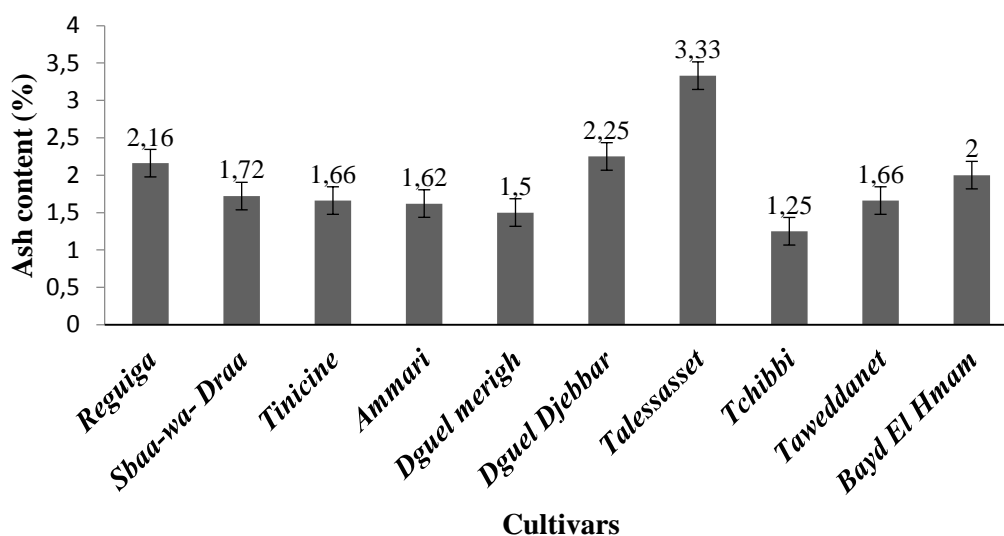


Figure 4.- Ash content of date fruit from ten date cultivar date harvested in the valley of Ouargla

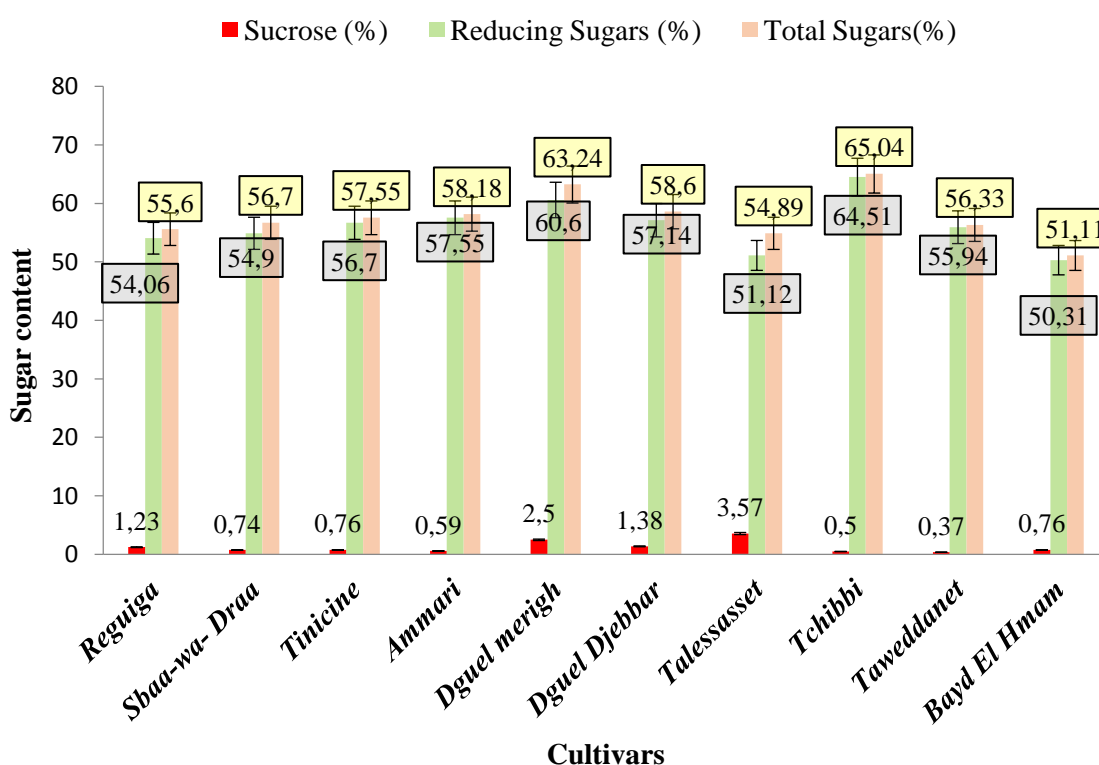


Figure 5.- Sugar percentage in date fruits from ten date cultivar harvested in the valley of Ouargla

2.3.- Valorisation perspectives

Evaluation of the potential of date fruits from various date cultivars to be transformed in to by-products was based on previous studies (tab. IV). The date fruits of the studied cultivars have morphological and biochemical characteristic that allow them to be valorised either by technological or biotechnological means. Indeed, the soft

consistency of the majority of date fruit cultivars, due to the presence of water, facilitates the production of paste and syrup. Cultivars with a dry consistency including *Dguel Djebbar* allow the production of flour; however, the use of cultivars without such consistency for the same purpose requires drying. In addition, the richness of these cultivars in sugars offers the possibility to produce vinegar, alcohol, and nutritional yeast.

Table IV.- Valuation methods proposed for the dates of ten cultivars studied (++: Good, +: average, -: bad)

	Characteristics of the products according to the bibliography	<i>Reguiga</i>	<i>Sbaa-wa-Draa</i>	<i>Tinicine</i>	<i>Ammari</i>	<i>Dguel Merigh</i>	<i>Dguel Djebbar</i>	<i>Talessasset</i>	<i>Tchibbi</i>	<i>Taweddane</i>	<i>Bayd El Hmam</i>
Technological Way	Date paste Munier [6], Ferry et al [13] Made from soft or semi-soft dates. It is used in cakes and for making ice cream	++	++	++	++	++	-	++	++	++	++
	Date flour Munier [6], Ferry et al [13] Is obtained by dry or dried dates. It is used in the preparation of many food products (food for infants and children)	+	+	+	+	+	++	+	+	+	+
	Date syrup According to Munier [6], the syrup can be made with any secondary quality date where the fruits are too watery. It is used in baking and to make hygienic drinks, and as a sweetener Mimouni and Siboukeur [9], used dates of dry, semi-soft consistency but soft dates are the most recommended.	++	++	++	++	++	+	++	++	++	++
Biotechnological Way	Date vinegar According to Munier [6], 100 kg of dates gives 300 to 400 l of vinegar at 6-7 °. Oueld El hadj et al [7], from cultivars of common dates of soft and dry consistency, Jemni and Mejri [11], the date juice extracted with 175 g / l of sugars and an acidity of 4,89 g / 100 ml gives a yield of 50,89% of vinegar.	++	++	++	++	++	++	++	++	++	++
	Alcohol Munier [6], per 200 kg of dates we get about 25 l of pure alcohol. Kaidi and Touzi [10], dates rich in sugars 60% make it possible to obtain ethyl alcohol at 92 °.	++	++	++	++	++	++	++	++	++	++
	Baking powder Dates can be used as a base for the	++	++	++	++	++	++	++	++	++	++

<p>production of nutritional yeasts [6]. Date juice, by its richness in sugars, constitutes a favorable medium for the development and growth of yeasts Arfa [8]. (Bourgois and Laepent, 1995), show that, 70 g of sugar gives 5 to 30 kg of dry matter of nutritional yeast.</p>										
---	--	--	--	--	--	--	--	--	--	--

3.- Discussion

We found a dominance of dark colours in the studied date fruits cultivars. DJOUDI (2013) [14] in his work on date fruits in the Ziban region, southern Algeria, showed that more than 83% of the cultivars have dark colours; mainly brown and black, and 16,6% of dates have light colours.

The majority of the cultivars of the studied date fruits are classified as soft dates. These results are similar with those obtained by DJOUDI (2013) [14] who found that dates of soft consistency have 54,7% dominance followed by 28,5% of semi-soft dates and 16,6% of dry dates. The work of IDDER *et al.* (2009) [15] in Ouargla done on 13 cultivars showed that 31,5% of dates are semi-soft dates.

The dimensions of the date fruits constitute a varietal character. SAYAH and OULD EL HADJ (2010) [16] recorded variance of length between 3,94 and 4,47 cm in dates of other cultivars. ACOURENE *et al.* (2001) [17] noted values for the diameter, which vary between 1,34 cm and 2,4 cm.

According to HARRAK and BOUJNAH (2012) [18], the L/D ration generally varied according to the shape of the fruit that is also an important varietal character. Sixty percent 60% of cultivars have a ratio that exceeds 1,91 which is the average ratio of all cultivars [18]. In fact, the shape of the fruits is almost spherical when the ratio is close to 1 (*Bayd El Hmam* and *Tchibbi* cultivars), while it has an elongated shape when L/D is close to 3; this is the case of date fruits from *Sbaa-wa-Draa* and *Tinicine* cultivars. Compared to Moroccan dates, HARRAK and BOUJNAH (2003) [19] found that this ratio varies on average between 1,48 and 2,06.

The weight of the date fruits constitutes a quality criterion of great value, it also differentiated between varieties [20]. ACOURENE *et al.* (2014) [21] noted values varying from 3,88 to 19,41 g for Algerian dates; the pulp to date ratio varied from 70,28% to 90,31%. These results are close to those of BOUSDIRA (2007) [22] on date fruits in the M'Zab valley which vary between 72% and 93%.

The found pH values are close to those reported by SAYAH and OULD EL HADJ (2010) [16]; 5,48 to 6,42. HARRAK and BOUJNAH (2012) [18] stated that the pH values of date fruits that tend towards neutrality could be an indicator of the good commercial quality.

According to HARRAK and BOUJNAH (2012) [18], water is one of the major constituents of the date fruit. It has a particular importance on the quality of date fruits and conditions of the aptitude for the conservation of the date fruit. The values of the water content of the studied date fruits are close to those obtained by BOOIJ *et al.* (1992) [23]

which are around 17% and 34%.

The work of BOOIJ *et al.* (1992) [23] has indicated that the proportion of mineral salts plays important functional roles; metabolic role in activating of numerous enzymatic systems and physicochemical role in controlling the pH, electrical neutrality, and electrochemical potential gradients.

MUNIER (1973) [6] claimed that the date fruit contains 2% ash. According to HARRAK and BOUJNAH (2012) [18], the ash rate varies from 1,5 to 3% but ACOURENE *et al.* (2001) [17] found 1,8 and 2,9 %.

Date fruits are very sweet fruits, their sugar content can reach up to 80% of the pulp weight [24], and this gives it great energy value. According to HARRAK and BOUJNAH (2001) [18], this fruit contains three major sugars: sucrose, glucose, and fructose. Nevertheless, this does not exclude the presence of other sugars such as galactose, xylose, and arabinose. The weakness of the sucrose content is due, according to BEN SAYAH (2014) [25], to the presence of water that enhances the inversion of sucrose to fructose and glucose. BEN SALEH and HELLALI (2006) [26] recorded lower contents for reducing sugars, which varied between 21,64 and 42,84%.

According to BOULAL *et al.* (2010) [27], common date fruits allow to obtain a good productivity of raw alcohol because of their chemical composition and their richness in mineral salts. ACOURENE *et al.* (2008) [28] noted that the scrap of date fruits, which is rich in sugars, can be transformed by biotechnological processes to obtain baker's yeast, alcohol, and vinegar.

Conclusion

Due to their physicochemical and biochemical elements, particularly minerals, water content, and sugars, the indigenous date fruits are substrates of choice to implement manufacturing their by-products in industry such as alcohol and nutritional yeast.

The use of technology and biotechnology to produce by-product from such cultivars would encourage farmers to preserve all the diversity of the date palm and encourage the planting of these cultivars. Consequently, the genetic diversity of the date palm will be preserved in the valley of Ouargla.

References

- [1].- FAO., 2019.- Statistiques sur la production en Algérie.
- [2].- Hannachi S., Khitri D., BenkhalifA A., et Brac de Perriere R.A., 1998.- Inventaire variétal de la palmeraie algérienne. Ed. Agence nationale d'éducation et de publication (Anep), Alger-Algérie, 225 p.
- [3].- IPGRI., 2005.- Descripteur du palmier dattier. Institut International Des Ressources Phylogénétiques. Edition international plant genetic resources institute, 72 p.
- [4].- Audigie C., Figarlla J. et Zonszain F., 1984.- Manipulation d'analyse biochimique. Doin, Paris, 273p.

- [5].- JCAM., 2007.- Quantitative Analysis of Sucrose in Confectionary. N°108, Ed. Japan Customs Analysis Methods, 12 p.
- [6].- Munier P., 1973.- Le palmier dattier. Techniques agricoles et productions tropicales. 5^e Maison neuve et Larose, Paris, 221 p.
- [7].- Ould El hadj M. D., Sebihi A. H., et Siboukeur, O., 2001.- Qualité Hygiénique et Caractéristiques Physico- Chimiques du Vinaigre Traditionnel de Quelques Variétés de Dattes de la Cuvette de Ouargla. Energ. Ren: Production et Valorisation – Biomasse, 87-92.
- [8].- Arfa D., 2008.- Suivi des Caractéristiques Microbiologiques et Physico chimiques des Jus des Dattes Conservés par Irradiation Gamma. Mémoire de Technicien Supérieur en Industries Agro-alimentaires. Institut Supérieur des études Technologiques de Zaghouan.
- [9].- Mimouni Y., et Siboukeur O., 2011.- Etude des propriétés nutritives et diététiques des sirops de dattes extraits par diffusion, en comparaison avec les sirops à haute teneur en fructose (isoglucoses), issus de l'industrie de l'amidon. Annales des Sciences et Technologie, 3: 1-11.
- [10].- Kaidi F., et Touzi, A., 2001.- Production de Bio-alcool à partir des déchets de dattes. Energ. Ren., Production et Valorisation – Biomasse, 75-78.
- [11].- Jemni M., et Mejri S., 2006.- Valorisation des écarts de triage de dattes. Cas d'application: Production biologique du vinaigre. Actes des 13^e Journées Scientifiques sur les Résultats de la Recherche Agricoles Hammamet, 8 p.
- [12].- Bourgois C. M. et Larpent J. P., 1995 - Microbiologie alimentaire Tome 2. Aliments fermentés et fermentations alimentaire. Technique et documentation Lavoisier, 523p.
- [13].- Ferry M., Bedrani S., et Greiner D., 1999 - Agroéconomie des Oasis. Edition CIRAD/ Montpellier, France, 176p.
- [14].- Djoudi I., 2013 - Contribution à l'identification et à la caractérisation de quelques accessions du palmier dattier (*Phoenix dactylifera* L.) dans la région de Biskra. Mémoire Magistère en agriculture et environnement en régions arides. Université Biskra, 96 p.
- [15].- Idder MA., Idder-Ighili H., Saggou H. et Pintureau B., 2009.- Taux d'infestation et morphologie de la pyrale des dattes *Ectomyelois ceratoniae* (Zeller) sur différentes variétés du palmier dattier (*Phoenix dactylifera* L.). Cahier Agriculture, 18 :63-71.
- [16].- Sayah Z., et Ould El hadj M.D., 2010.- Etude comparative des caractéristiques physico-chimiques et biochimiques des dattes de la cuvette de Ouargla. Annales des Sciences et Technologie, 2 : 23-31.
- [17].- Acourene S., Belguedj, M., Tama M. et Taleb B., 2001 - Caractérisation, Evaluation de la qualité de la datte et identification des cultivars rares de palmier dattier de la

région des Ziban. Recherche agronomique, INRAA, Pp 19-39.

- [18].- Harrak H., et Boujnah M., 2012 - Valorisation technologique des dattes au Maroc. INRA, Rabat, Maroc, 155 p.
- [19].- Harrak H., et Boujnah M., 2003- Caractérisations physiques et morphologiques des principales variétés de dattes marocaines. Al Awamia, 107 : 59-76.
- [20].- Taouda H., Mrani Alaoui M.F., Chabir R., et Aarab L., 2014 - Etude comparative des caractéristiques morpho-métriques et Biochimiques des dattes commercialisées dans le marché régional de FES / MAROC. International Journal of Innovation and Applied Studies, 8: 1-10.
- [21].- Acourene S., Djafri K., Benchabane A., Tama M. et Taleb, B., 2014 - Dates quality assessment of the main date palm cultivars grown in Algeria. Annual Research Review in Biology, 4 : 487-499.
- [22].- Bousdira K., 2007 - Contribution à la connaissance de la biodiversité du palmier dattier pour une meilleure gestion et une valorisation de la biomasse, caractérisation morphologique et biochimique des dattes des cultivars les plus connus de la région du Mzab, classification et évaluation de la qualité. Mémoire Magistère en Technologie Alimentaire. Université Boumerdès, 149 p.
- [23].- Booij I., Piombo G., Risterucci J. M., COUPE M. and Thomas D., 1992.- Study on the chemical composition of dates at different stages of maturity for the varietal characterization of various cultivars of palm trees (*Phoenix dactylifera* L). Fruits,47 : 667-678.
- [24].- Munier P., 1965.- Le palmier dattier, producteur de sucre. Fruit, 20 : 577- 579.
- [25] Ben Sayah F., 2014 - Influence des conditions de stockage au froid des dattes sur leur organoleptique dans la région des Ziban (Cas des dattes - variété *Deglet Nour*). Mémoire magistère. Université de Ouargla. 99p.
- [26] Ben Saleh M., et Hellali R., 2006.- Composition chimique des fruits de 15 cultivars tunisiens de palmier dattier (*Phoenix dactylifera* L.). Plant Genetic Resources Newsletter, 148 : 1-7.
- [27].- Boulal A., Benali B., Moulai M., et Touzi A., 2010.- Transformation des déchets de dattes de la région d'Adrar en bioéthanol. Energies renouvelables, 13 : 455- 463.
- [28].- Acourene S., Ammouche A. et Djaafri K., 2008 - Valorisation des rebuts de dattes par la production de la levure boulangère, de l'alcool et du vinaigre. Sciences et Technologie, 28: 38 - 45.