IOSR Journal of Biotechnology and Biochemistry (IOSR-JBB)
ISSN: 2455-264X, Volume 7, Issue 2 (Mar. – Apr. 2021), PP 35-45
www.iosrjournals.org

Assessment of the physico-chemical and sensory qualities of Moroccan date syrup: optimization of extraction and conservation

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Abstract:
Background*: Food evaluation and processing play a key role in food preservation. In this context, this work has two main objectives. The first consists of extracting the syrup from two varieties of Moroccan dates, trying to optimize the parameters that influence the extraction. While the second, focuses on the study of the sensory analyses and physico-chemical parameters that influence the preservation of the extracted syrup: pH, titratable acidity and water content.*
Materials and Methods*: The study was carried out on two Moroccan varieties, namely Bouffegouss and Fertat. The syrups were extracted by diffusion by setting the following parameters: temperature, time and the water: pulp ratio. The evaluation of the quality of the syrups extracted was carried out by determining the physicochemical characteristics according to the French standard (NF), as well as the sensory analyzes.*
Results*: In this article, we were able to identify a set of optimal conditions for extraction by design of experiments. Carry out several sensory, physical and chemical analyzes and their variations with the factors studied. Finally, we compared the results obtained by the optimal extraction and pH conditions, which results in good storage.*
After an appropriate choice of the variables influencing the extraction, namely: the temperature (80°C; 90°C), the time (60min; 90min) and the fixed water ratio (1:2); Four experiments led to a response allowing knowledge of the optimal conditions necessary to get and secure a minimum pH and a maximum syrup yield.
Conclusion: *The results obtained during this study are promising, present an economical and efficient strategy: minimum energy and time with maximum lifespan.*
Key Word*: Conservation; Moroccan date syrup; Optimization; Physico-chemical parameters; Sensory analysis; Quality.*

Date of Submission: 15-04-2021 Date of Acceptance: 29-04-2021

I. Introduction

The date palm is a tree that lives in hot and dry climate. Because of its food, ecological, social and economic uses, the date palm is the most appreciated fruit tree by the oasis populations1.

In Morocco, date palms cover an area of 50,000 hectares in the south and south-east, representing nearly 4.8 million palm trees, with production reaching 120,000 tonnes in 2011[2]. This quantity remains completely non-consumable, so for the goods to benefit, researchers have to find good conditions for conservation or processing.

Because of their consumption and high production, dates are the focus of much research attention, both in terms of nutrition and energy; since dates are characterised by their high energy value, they yield 3000 calories per kilogram of date in viron sugar[3]. As well as the valorisation of by-products by making: powder, drink, vinegar and or even sugar alternatives [4, 5].

Dates have been the subject of many studies; it has been prompted by several authors. One of the researches carried out on date processing is the study and description of the methods and techniques for preparing food products based on dates (rob) [6]. In addition, in the field of biomass, a study has been established which consists of developing a biotechnological process to use the sugars from date by-products as a source of carbon to produce a biofuel [7].

The goal of the present work is to optimize the factors influencing the extraction of date syrup in order to obtain a better extraction yield, in addition to studying the interaction of the parameters to minimize the pH. With the use of experimental designs that has allowed us to draw the best possible precision in terms of results with the minimum of tests.

II. Material And Methods

Plant materials: This study is carried out on two varieties of Moroccan dates Boufegouss (molle) and fertat (dry), which are widely distributed in the Daraa-Tafilalt area. The latter represents 90% of Moroccan date production [8]; the choice of these varieties is justified by its availability on the market and their consumption.

As already mentioned, our goal is to have a better yield of date syrup by adjusting the conditions in each extraction as well as looking for an optimal range to minimize pH in order to increase the life of date by-products.

Before proceeding to the extraction, we carried out a pitting then washing and cutting 5:

- Washing: removes soil particles and possibly pesticide residues.
- Stoning: this is done entirely by hand, and allows the removal of the date kernel.
- Cutting: this is an operation that allows the pulp obtained to be cut into small pieces to facilitate extraction.

Arriving at the most important stage is the extraction of juice in several conditions:

- 1st extraction: the dates previously washed, pitted and cut (30g) are soaked in twice their weight of water, and then put in a water bath with the variation of temperature and time, under agitation maintained throughout the operation[7].
- 2nd extraction: in a beaker put the residual pulp of the first extraction and a volume of water which is twice the mass used [7].

The last step is the filtration of the pulp, the juice obtained also undergoes evaporation under the same conditions (time, temperatures) to eliminate the free water, finally obtaining syrup.

Physical and morphological characterization of studied dates : The physical and morphological characteristics are carried out on 15 randomly selected fruits, for which are determined: consistency, shape, color, as well as the weight of dates, pulp, stone by means of a precision balance[9].

Physico-chemical analyses : All analyses were performed at the Engineering and Applied Technology Laboratory, Higher School of Technology -Beni Mellal. The samples of the extracted syrup undergo several chemical analyses:

- **Determination of pH (Dowson and Aten 1963):** By a direct reading with a thermo-scientific pH meter, we can determine the pH of the syrup obtained under all conditions[10].
- **Titratable acidity (method NF V04-206 or Titrimetry):** It consists in performing an acidity assay of an aqueous solution with a sodium hydroxide solution (NaOH 0.1N) in the presence of phenolphthalein as a color indicator; the assay is stopped at a pH which designates the turning point of the phenolphthalein to the rose[11].

The titratable acidity is expressed in grams of acetic acid per 100 g of product (dates):

$$Ay_0 = \frac{250}{25} \times \frac{V1}{10} \times \frac{100}{V} = 150 \times \frac{V1}{V}$$

With,
Ay0: Titratable acidity
m: Test sample mass (g)
V: Volume of filtrate taken for the draw (ml)
V1: Volume of sodium hydroxide solution 0.1N (ml)

- **Density Determination :** The density of a syrup makes it possible to estimate the rate of its dry matter and is of considerable importance insofar as it gives information on the aptitude of the micro-organisms which develop there [12].

$$d = \frac{density\ l}{density\ e} = \frac{m_L}{v_L}$$

With,
d : The density of the liquid
m_L: Test sample mass
v_L: Volume of the test sample

- **Determination of the total dry residue (method NF V05-105):** The dry matter content was determined by drying 2 g of pulp in an oven at a temperature of 105 ± 2°C[7].

The total dry residue is expressed as a percentage of the mass:

$$\frac{0}{0}M = \frac{(m_2 - m_0)}{m_1} \times 100$$ [7]

With,

m_0: Mass of the empty capsule (g).

m_1: Test sample mass (g).

m_2: Final mass after drying (dry matter + capsule) (g).

- **Moisture content:** The water content is determined by the same working condition in the determination of the total dry residue, but in this case the water percentage is calculated with the following equation [9]:

$$MH\% = \frac{m_1 - (m_2 - m_0)}{m_1} \times 100$$

With,

MH%: Water content (%)
m0: Mass of the empty capsule (g).
m1: Test sample mass (g).
m2: Final mass after drying (dry matter + capsule) (g).

Sensory analysis (organoleptic test): Sensory analysis is an examination of the organoleptic properties of a product by the sensory organs, and is thus the basis of any judgment of a food product. It aims to ensure consumer satisfaction while minimizing losses for the manufacturer and the retailer[4].

Experimental designs and experimental areas of factors: The experimental method chosen should facilitate the interpretation of the results; it should also minimize the number of tests without sacrificing quality. Experimental design theory provides the conditions under which the best possible accuracy can be obtained with the minimum number of trials[7].

In this work, we focused on the most important parameters acting on the extraction yield as well as on the physico-chemical characteristics.

These tests are carried out by maintaining fixed the water ratio (1:2). So, we have varied other factors such as:

- The extraction temperature is between 80 and 90˚C with a variation step equal to 10.
- For the time we used two values 60 and 90 min for the extraction of the juice from the dates.

There are two factors at two levels so the experimental field can be represented as follows [13]:

- The number of trials for this experimental design is: n=2k=2x2=4
- The superscript k means that there are k factors being studied.
- The 2 indicates the number of levels per factor.

Table n°1: Experimental areas of the factors studied

Number of tests	Temperatures1	Time 2
1	-1	-1
2	+1	-1
3	-1	+1
4	+1	+1

Level -1	80°C	60 min
Level +1	90°C	90 min

III. Results and discussions

Physical and morphological characterization of dates: The morphological and physical characteristics of the two varieties of dates studied boufegouss and fertat ; are presented in the table n°2. The results obtained are the mean of 15 samples (± standard deviation).

Table n°2: Morphological and physical characteristics of two varieties of dates

Settings	**Boufegouss variety**	**Fertat variety**
Form	Oval	Oval
Consistency	Molle	Dry
Texture	Fiber, elastic, viscous	Elastic, non-viscous
The appearance of the epicarp	Shiny and smooth	Smooth
Pulp color (epicarp)	Brown	Yellowish brown
Mesocarp color	Brown	Golden brown-yellow

The color of the core	Brown	Brown
Mass of the whole date (g)	10.89±1.84	5.38±1.51
Mass of pulp (g)	9.30±1.42	4.6±1.42
Core mass (g)	1.62±0.37	0.77±0.12
Length of the date (cm)	3.63±0.25	2.82±0.30
Width of the date (cm)	2.42±0.40	1.73±0.27
Core / whole date %.	14.87	14.31
Pulp / whole date %.	85.39	85.5

According to the results mentioned in table n°2, the two varieties of dates are physically and morphologically different from each other.We can see that the two varieties have the same shape, but the consistency has deference from mole to dry which is explained by the water content. Indeed, dates of Boufegouss have an elastic and viscous fibrous texture; on the other hand dry dates have an elastic non-viscous texture. The color of the fruit and generally brown and yellowish brown, which gave a general idea of the level of maturity and the state of freshness of the dates[14]; these results are admissible if we take into consideration the results obtained by H. Harrak, who found that if the color tends towards black, it indicates the presence of a low commercial value even if it provides an excellent taste[2]. For the weight there is an important difference in which the total mass of dates of Boufegouss variety on average is greater compared to the Fertat variety, but the ratio of the mass of kernel on the whole date and the mass of pulp on the whole dates are almost identical. These morphological differentiations are due to the different pollination techniques of the date palm[15, 16].

In addition, morphometrically the Boufegouss variety has a better quality with an average date weight of 10.89±1.84, a length of 3.63±0.25 and 2.42±0.4 in width. This is based on the scale proposed by H.Taouda, who points out that the best quality dates are characterized by a whole date mass greater than 6g and values greater than 3.5cm and 1.5cm respectively for length and width [17]. At the same time, these results imply that the Fertat variety has acceptable quality with values equal to 5.38±1.51 for the whole date mass and 2.82±0.3, 1.73±0.27 respectively for length and width.

Optimization of extraction: Several parameters act on the variation of the date juice extraction yield. Each parameter has its importance in the good functioning of the extraction. A series of tests was made at laboratory level; with the aim of optimizing two essential parameters: temperature (X1) and time (X2)[13]. Its tests are carried out on the two studied varieties; the table n°3 represents the results obtained.

Table n°3: Matrix of experiences and extraction responses

			Boufegouss variety		**Fertat variety**	
Trial number	**Temperatures**	**Time**	**1st extraction**	**2nd extraction**	**1st extraction**	**2nd extraction**
1	-1	-1	93.53	83.42	84.86	63.76
2	-1	1	86.1	65.96	80.27	78.02
3	1	-1	92.79	55.89	79.16	82.44
4	1	1	76.75	92.43	81.99	79.85

- **Student Test:** Allows predicting whether the coefficients of the obtained mathematical model are significant or not, the table n°4 groups all the coefficients of the model and their meanings. It appears that if we set a significance threshold of 5%, can be considered significant in addition to b0, the coefficients b1, b2 and b12 which correspond respectively to the influences of the factor temperatures, time and temperature-time interactions (S: Significant)[18].

Table n° 4: Extraction model coefficients and significance of factors

	Boufegouss variety			**Fertat variety**		
	Coefficient		**Meaning**	**Coefficient**		**Meaning**
	1st extraction	**2nd extraction**		**1st extraction**	**2nd extraction**	
b0	87.29	74.425	S	81.57	76.0175	S
b1	-5.8675	4.77	S	-0.44	2.9175	S
b2	-2.5225	-0.265	S	-0.995	5.1275	S
b12	-2.1525	13.5	S	1.855	-4.2125	S

According to the results of the table n°4 we notice that for the 1st extraction of the two varieties, the values are very close, so we cannot neglect one value in front of the other. On the other hand, the 2nd extraction of the Boufegouss variety gives a coefficient of the time equal to -0.265 and is lower than the temperature 4.77 and 13.5 for the interaction of the two parameters; therefore, we can say that the time is inefficient, but we cannot neglect it because it enters in the interaction with the temperature. Therefore, both parameters and their interactions are significant.

- **Mathematical models obtained**

The results of all the experiments are entered into the appropriate software (JMP) which, thanks to the statistical calculations, gives the equation of the response according to the different factors [13]. This equation is called the model equation, is the mathematical model postulated that is used, in general, with the full factorial design EP is a first-degree model for two factors the model is:

Y1 = 87.29 - 5.8675 **X1** – 2.5225 **X2** – 2.1525 **X1X2**
Y2 = 74.425 + 4.77 **X1** – 0.265 **X2** + 13.5 **X1X2**
Y'1 = 81.57 - 0.44 **X1** - 0.995 **X2** + 1.855 **X1X2**
Y'2 =76.0175 + 2.9175 **X1** + 5.1275 **X2** - 4, 2125 **X1X2**
Y1: Represents the yield of 1st Boufegouss variety extraction estimated by the obtained model.
Y2: Represents the yield of 2nd Boufegouss variety extraction estimated by the obtained model.
Y'1: Represents the yield of 1st Fertat variety extraction estimated by the model obtained.
Y'2: Represents the yield of 2nd Fertat variety extraction estimated by the model obtained.

- **Optimization of the response:** Once the model has been defined, the temperature optimization and time must finally be determined. This means finding the optimal conditions for each of the factors, taking into account their interactions. We therefore used the method of plotting is a response curves.

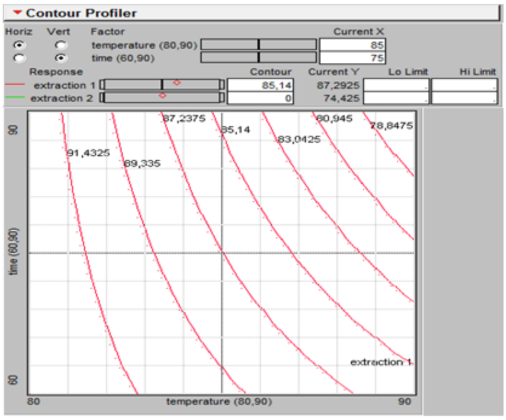

Figure1: 2D representation of the variation of temp=f(temperature)of the 1st extraction of the Boufegouss variety

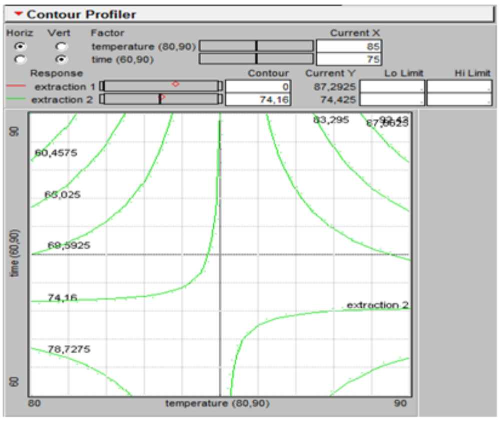

Figure 2: 2D representation of the variation of temp=f(temperature) of the 2nd extraction of the Boufegouss variety

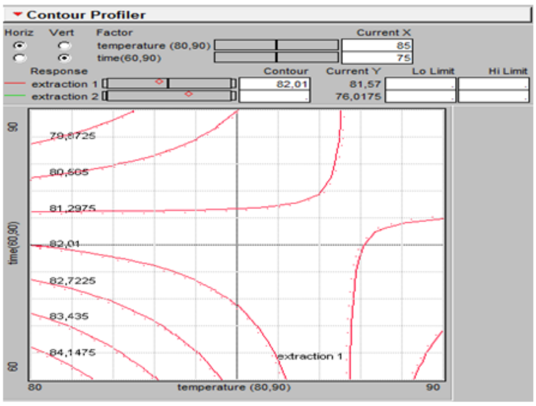

Figure3: 2D representation of the variation of temp=f(temperature)of the 1st extraction Fertat variety

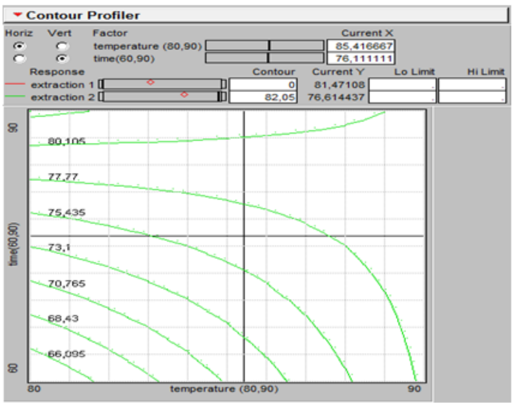

Figure 4: 2D representation of the variation of temp=f(temperature) of the 2nd extraction Fertat variety

Boufegouss variety

- **1st extraction:** Figure 1 shows the yield of the 1st extraction as a function of temperature and time. These figures allow us to find the optimum range of the two factors. We only find the optimal response found in the domain corresponding respectively to a temperature ratio between [80˚C; 83 ˚C] and between [60min; 70 min] for the time ratio, these domains correspond to a yield between 89.33% and 91.43%.
- **2nd extraction:** Figure 2 shows the time variation as a function of temperature. Thus, the optimal range is [87˚C; 89˚C] for temperature and between [75min; 85min] for time, these ranges correspond to an efficiency between 83.29% and 87.66%.

Fertat variety

- **1st extraction:** Figure 3 allows us to deduce that the optimal value of the response is in the range where the temperature corresponds to [81˚C; 83.5˚C] and [60min; 70min] for time. These domains correspond to a yield between 83.43% and 84.14%.
- **2nd extraction:** The optimal range for Fertat variety extraction is [88˚C; 90˚C] for temperature and between [80 min; 90min] for time. These ranges correspond to a yield between 77.77% and 80.1%.

Table n°5: Optimum range of studied factors for syrup extraction

		Factors	Experimental field
Boufegouss variety	1st extraction	Temperatures	[80˚C; 83 ˚C]
		Time	[60min; 70 min]
	2nd extraction	Temperatures	[87˚C; 89˚C]
		Time	[75min; 85min]
Fertat variety	1st extraction	Temperatures	[81˚C; 83.5˚C]
		Time	[60min; 70min]
	2nd extraction	Temperatures	[88˚C; 90˚C]
		Time	[80 min; 90 min]

We conclude that both parameters increase when moving from the 1st extraction to the 2nd extraction; according to S.Chniti who finds that syrups extracted under the following conditions (80˚C, 90min, 1:2 pulp/water) are rich in sugar[7]. We can say that these results are close to the values mentioned in the table n°5. Therefore, in general, the conditions in which a good syrup yield is obtained are relatively suitable with the sugar optimization results.

The pH: It is an essential index in the growth of bacteria, which influences the preservation of food[19]. Therefore, it is important to measure the pH, in order to optimize the factors useful to minimize the pH value. The table n°6 represents the values obtained.

Table n°6: Matrix of experiences and pH responses

			Boufegouss variety		Fertat variety	
Trial number	**Temperature**	**Time**	1st extraction	2nd extraction	1st extraction	2nd extraction
1	-1	-1	6.55	6.54	5.72	6.44
2	-1	1	6.71	6.71	5.71	6.73
3	1	-1	6.59	6.87	5.51	6.45
4	1	1	6.55	6.55	5.51	6.45

- **Student Test:** The coefficients of all the factors that examine their meanings are grouped together in table n°7. The coefficient values are used to determine the significance and effects of the two parameters temperature and time on pH. So, if the coefficient value of one parameter is negligible in comparison to the other, it can be said to be insignificant [18].

The statistical coefficients are: - b0: constant;
- b1: temperature influence;
- b2: time influence;
- b12: influence of interaction between the two factors.

Table n°7: pH model coefficients and significance of factors

	Boufegouss variety			Fertat variety		
	Coefficient		Meaning	Coefficient		Meaning
	1st extraction	2nd extraction		1st extraction	2nd extraction	
b0	6.6	6.645	S	5.6125	6.5175	S
b1	0.03	-0.015	S	-0.0025	0.0725	S
b2	-0.03	0.02	S	-0.1025	-0.0675	S
b12	-0.05	-0.1	S	0.0025	-0.0725	S

Taking into account the results mentioned in the table n°7 we notice that all the coefficients are close, one to the other, since we cannot neglect one in front of the other. Thus we conclude that the two parameters and thus their interactions have almost identical effects in the minimization of pH.

- **Mathematical models obtained**

The mathematical models are given by the following equations:

$\mathbf{Y1} = 6.6 + 0.03\,\mathbf{X1} - 0.03\,\mathbf{X2} - 0.05\,\mathbf{X1X2}$

$\mathbf{Y2} = 6.645 - 0.015\,\mathbf{X1} + 0.645 - 0.1\,\mathbf{X1X2}$

$\mathbf{Y'}1=5.6125 - 0.0025\,X1 - 0.1025\,\mathbf{X2} + 0.0025\,\mathbf{X1X2}$

$\mathbf{Y'2} = 6.5175 + 0.0725\,\mathbf{X1} - 0.0675\,\mathbf{X2} - 0.0725\,\mathbf{X1X2}$

Y1: Represents the yield of 1st Boufegouss variety extraction estimated by the model obtained.
Y2: Represents the yield of 2nd Boufegouss variety extraction estimated by the model obtained.
Y'1: Represents the yield of 1st Fertat variety extraction estimated by the model obtained.
Y'2: Represents the yield of 2nd Fertat variety extraction estimated by the model obtained.

- **Optimization of the response**

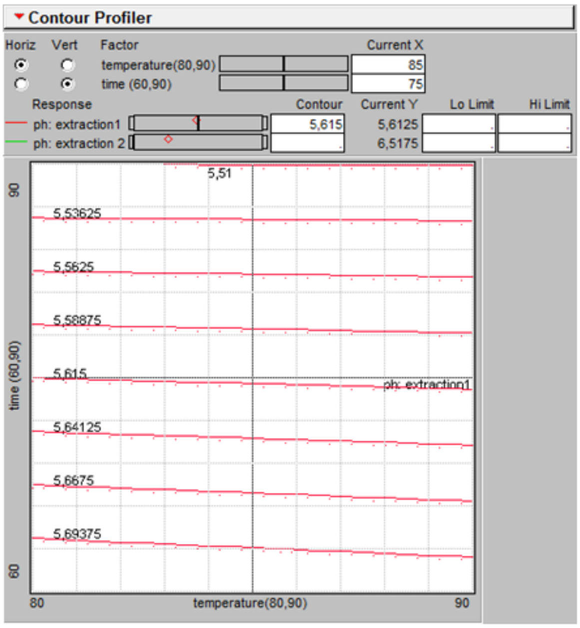

Figure 5: 2D representation of the variation of temp=f(temperature) of the 1st extraction of the Boufegouss variety

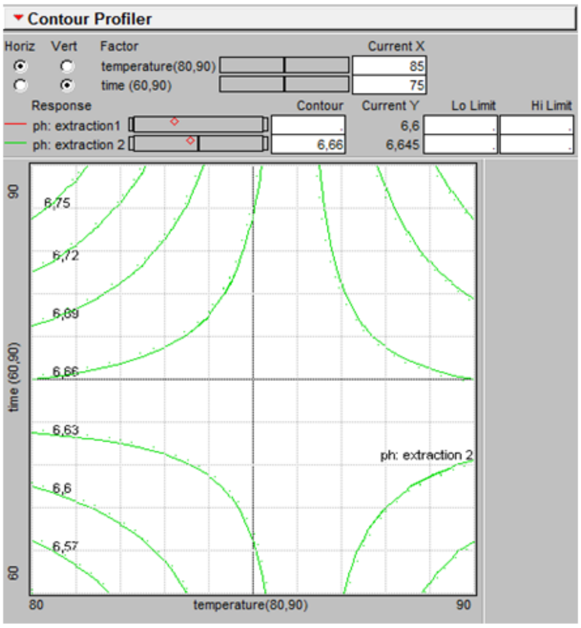

Figure 6: 2D representation of the variation of temp=f(temperature) of the 2nd extraction of the Boufegouss variety

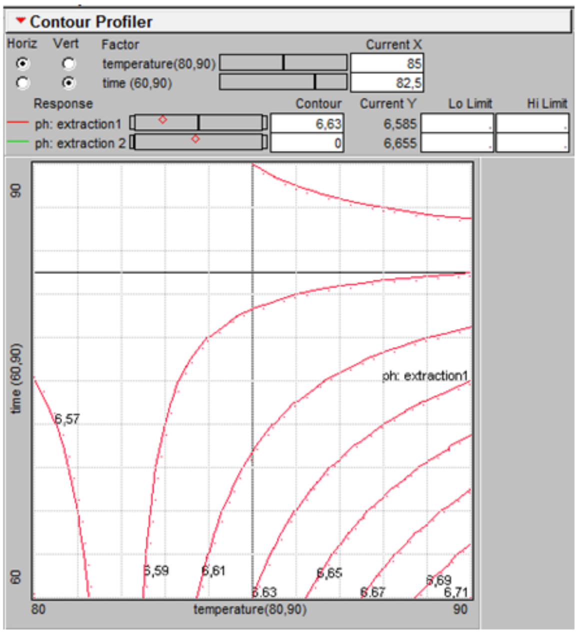

Figure 7: 2D representation of the variation of temp=f(temperature) of the 1st extraction of the Fertat variety

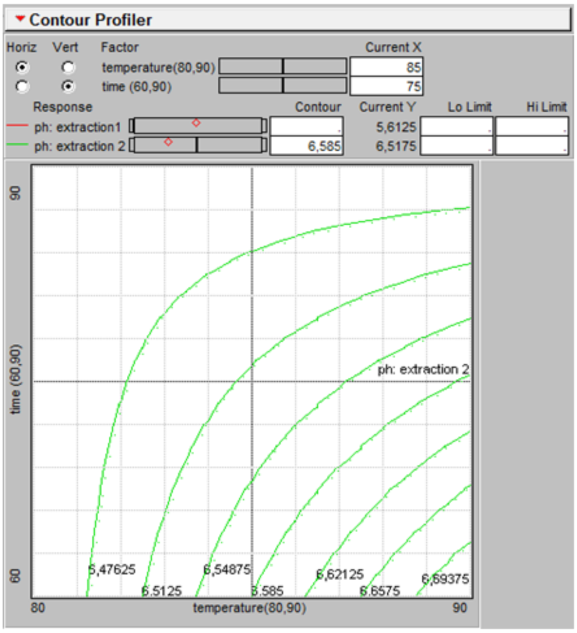

Figure 8: 2D representation of the variation of temp=f(temperature) of the 2nd extraction of the Ferttat variety

Boufegouss variety

- **1st extraction:** according to the profile shown in figure 5, the optimal domains of the factors studied, temperature and time, are respectively [81˚C; 83 ˚C] and [74min; 85 min]. These domains correspond to a pH varying between 6.57 and 6.59.
- **2nd extraction:** the figure 6 shows the influence of time and temperature of date by-product extraction on pH, noting that the optimal range is [81˚C; 83 ˚C] for temperature and [85min; 95min] for time. These domains correspond to a pH between 5.47 and 6.51.

Fertat variety

- **1st extraction:** in figure 7 the minimum factor ranges for having a desired pH interval (5.51 to 5.53) are [82˚C; 84˚C] for temperature and [85min; 90min] for time.
- **2nd extraction:** the results in figure 8 indicate that obtaining pH between 6.57 and 6.6 requires an equal temperature interval [81˚C; 84˚C], and [60min; 70min].

According to these results, we observe that the temperature of syrup extraction to minimize the pH in order to increase the life span of the syrup, is in the vicinity of 80˚C and a time of 90min for the 2nd extraction of boufegouss variety and the 1st extraction for fertat; these results are compatible with the one obtained by S.Chniti (80˚C; 90)[7]. In addition, the pH results obtained are higher than those found by N.Belguedj and S.chniti at values of 4.24±0.12 and 4.34±0.02[6, 7].

Titratable acidity: The titratable acidity is a biochemical parameter used in the determination of the state of maturity of the fruits, is also related to the taste of the food and is one of the most important factors in the growth of microorganisms [20]. The titratable acidity results of our varieties are presented in table n°8. (All values are expressed in grams of acetic acid per 100 g of dates).

Table n°8: Titratable acidity of syrups of two varieties of dates

	Boufegouss variety		**Ferttat variety**	
Condition	1st extraction	2nd extraction	1st extraction	2nd extraction
(80˚C ; 60min)	1.25	1.075	2.675	1.325
(80˚C ; 90min)	1.075	0.425	2.17	1.075
(90˚C ; 60min)	1.5	-	2.65	0.5
(90˚C ; 90min)	1.5	1	2.075	1.25

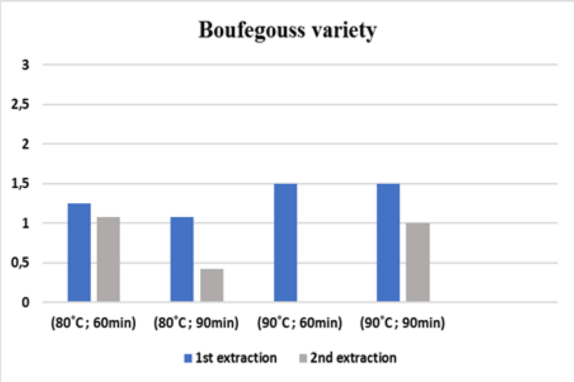

Figure 9: Titrable acidities of Boufegouss variety syrups for each extraction condition

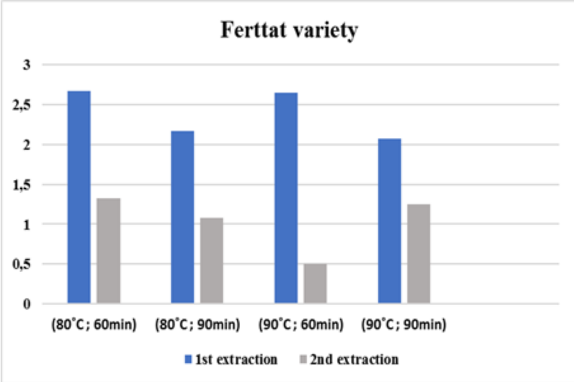

Figure 10 : Titratable acidities of Fertat variety syrups for each extraction condition

According to the results presented in the table n°8, we notice that the acidity of the juices of Boufegouss variety is in percentage of the order of 1.075% to 1.5% for the first extraction. Followed by the acidity of second extraction with values ranging from 0.425% to 1%. In addition to the titratable acidity values of 2.075% to 2.675% and 0.5% to 1.325% were also recorded respectively on the first and second extraction of Fertat variety. In fact, the titratable acidity results of the various extraction parameters are higher when compared with the results of S.Chniti which found a value of 0.22±3[7].

From Figures 9 and 10, we see that the first extraction is more acidic compared to the second extraction for both grades. Also, we clearly notice that the titratable acidity of the Fertat variety juice is higher than that of the Boufegouss variety. So, we can say that a high titratable acidity is often associated with Fertat variety of extracted dates.

According to the extraction and pH optimization results, the interaction of optimal domains are [80˚C;83 ˚C], [60min; 85 min] and [81˚C; 89 ˚C], [75min;95min] respectively for the 1st and 2nd Boufegouss variety extraction, arriving at the Fertat variety in which [81˚C; 84˚C], [60min; 90min] for the 1st extraction and [81˚C; 90˚C], [60min;90min] for the 2nd extraction were found. So according to figure 9 & 10, the good working conditions are (80˚C; 90min), (90˚C; 60min) for the Boufegouss variety dates, and (80˚C; 60min), (80˚C; 90min) for the Fertat variety. The results of this study allow us to conclude that the above conditions are compatible with the values of titratable acidity.

Density and dry residue: Density and total dry residue results from all our extraction conditions for both grades of dates are shown in table n°9.

Table n°9: Density and the dry residue in syrups of two varieties.

	Boufegouss variety		**Ferttat variety**	
	1st extraction	2nd extraction	1st extraction	2nd extraction
Density	0.558 à 0.995	0.564 à 0.844	0.106 à 0.899	0.847 à 0.946
Dry Residue %	26 à 30	20.5 à 27	14.5 à 36	47 à 57.5

The study of the two parameters density and total dry residue gives a very important idea of the water activity. It is considered one of the main factors that should inhibit microbial growth. In the same order the water essential for the stability of food and increased its hard life.

The density of date by-products varies with the conditions of extraction, in which we note that the density of 1st extraction varies from 0.558 to 0.995, these values and slightly higher than the 2nd extraction that finds the interval follow [0.564; 0.844]. Passing to the Fertat variety allows having a variation of density up to 0.793 ranging from 0.106 to 0.899. Given these results, there is an observable increase from 0.847 to 0.946 for the second extraction. We can say that the density values are lower than the 1.43 obtained by Mimouni and Siboukeur (2009) [21]; whereas according to the work of Abdlfatah (1990) who reports that high density allows for long term storage [22].

The total dry residue recorded for both varieties in deferential extraction condition increases with increasing density. However, the results of Boufegouss variety syrops remain less dense than the Fertat variety. All this explains why Boufegouss variety syrops contain an important water component [9].

Moisture content: Everybody agrees that water is the secret of life for all living beings, even if microorganisms, which play a primordial role in the proliferation of food [23]. In addition, JL.Multon stressed that the water activity of food is a very sensitive factor that enters into the kinetics of food degradation [24]. Thus, we proceeded to determine the water content for the extracted syrup. The results obtained for the two varieties represented in the table n°10.

Table n°10: Moisture content of two varieties.

	Boufegousse Variety		Fertat variety	
	1st extraction	**2nd extraction**	**1st extraction**	**2nd extraction**
Moisture content	70 – 74%	73-79.5	64-85.5	42.5-53

According to the results in the table n°10 the moisture measurement of the syrup of the dates of both varieties is very high ; since we find values from 70 to 74% and from 73 to 79.5% for the 1st and 2nd extraction of Boufegouss variety. Moreover, we obtain values from 64 to 85.5% and from 42.5 to 53 for the other variety. These results are higher than those announced by N.Belguedj, i.e. 24.71±1.11%[6]. And this increase is due to evaporation, which is not done in an ideal way. As a result, syrups extracted from the Boufegousse variety will be more exposed to microbial interaction compared to the Fertat variety.

Sensory analysis: The tasting of the date syrups was carried out by a jury composed of 10 panelists. The purpose of this test is to have an opinion on the general acceptance of the experimental batches of date syrup and to bring out the best product organoleptically. Tables' n°11 and n°12 summarize the results obtained.

Table n°11: Results of sensory analysis on scale/10 of Boufegouss variety syrups

	1st extraction				2nd extraction			
	(80˚C; 60min)	(80˚C ; 90min)	(90˚C; 60min)	(90˚C ; 90min)	(80˚C ; 60min)	(80˚C ; 90min)	(90˚C ; 60min)	(90˚C ; 90mi)
Odor	3.25±0.5	2.5±0.57	3±0	2.75±0.5	2.25±0.5	2.25±0.5	2.5±0.57	1.5±0.57
Taste	4±0	3.25±0.5	3.25±0.5	4±0	3.75±0.5	2.75±0.5	2.25±0.5	2.5±0.57
Residual Taste	0.25±0.5	1.25±0.5	1.5±0.57	1.25±0.5	0.5±0.57	0.75±0.5	0.5±0.57	0.25
Color	3.75±0.5	4±0	3.75±0.5	4±0	2.75±0.5	3.25±0.5	3.25±0,5	3.24
Viscosity	3.5±0.57	3±0	3±0	3.25±0.5	2±0	2.25±0.5	2.25±0.5	2±0
Acceptance	4.75±0.5	3.75±0.5	3.25±0.5	3±0	3.75±0.5	3±0	2.5±0.57	2.75

Table n° 12: Results of sensory analysis on scale/10 of Fertat variety syrups

	1st extraction				2nd extraction			
	(80˚C ; 60mi)	(80˚C ; 90min)	(90˚C ; 60min)	(90˚C ; 90min)	(80˚C ; 60min)	(80˚C ; 90min)	(90˚C ; 60min)	(90˚C ; 90mi)
Odor	3.25±0.5	2.75±0.5	2.5±0.57	2.75±0.81	1.25±0.5	1.75±0.5	0.75±0.5	1.25±0.5
Taste	4±0.81	3±0.81	3.75±0.5	4.25±0.5	3.25±0.5	3.75±0.5	4±0.95	3.75±0.5
Residual Taste	1.25±0.5	1.75±0.5	1.25±0.95	1.25±0.5	0.25±0.95	0.5±1	0.25±0.5	0.75±0.5
Color	3±0.81	4±0	3.5±0.57	4±0	3.25±0.5	2.25±0.5	2.75±0.5	3.25±0.95
Viscosity	4.75±0.5	3.5±0.57	4.75±0.5	3.25±0.5	2±0	2±0	2.25±0.95	2.75±0.5
Acceptance	4.5±0.57	3.25±0.,5	4.25±0.95	3.5±1	2.75±0.5	3±0.81	4.75±0.5	4.25±0.5

According to the results recorded, it is noticeable that the syrups of two varieties and in all extraction conditions were judged by the majority of the tasters as being average with excellent acceptability. More precisely, the conditions (80˚C; 60min) and (80˚C; 90min) give maximum acceptability for both extractions of the Boufegouss variety; and then, (80˚C; 60min) and (90˚C; 60min) are the optimal conditions for the syrups of Fertat variety.

In general, all the organoleptic characteristics are diminished from the first extraction to the second; in particular the smell, color and residual taste in which a significant decrease in the tasters' judgement is clearly noticed when passing from the first to the second extraction. All this can be explained with the extraction of all the sugars and minerals in the first extraction. So as a conclusion, temperature and time influence the organoleptic quality of date syrups. The favorable conditions for excellent acceptability are compatible with the optimal ranges for extraction and pH.

IV. Conclusion

This work focused on two varieties of dates of different consistency, soft and dry. We were mainly interested in the optimization of date by-product extraction parameters and in the study of the physicochemical factors that influence the conservation of the latter.

The study of the physico-chemical and organoleptic characteristics of syrups derived from dates of two varieties obtained by diffusion of the variation of two parameters: temperature and time. Thanks to the experimental designs, we were able to model and optimize these parameters, and we have drawn the following results:

- The interaction of the optimal extraction domains and the pH minimization are [80˚C; 83 ˚C], [60min; 85 min] and [81˚C; 89 ˚C], [75min; 95min] respectively for the 1st and 2nd Boufegouss variety extraction.
- In addition, for the Fertat variety in which we found [81˚C; 84˚C], [60min; 90min] for the 1st extraction and [81˚C; 90˚C], [60min; 90min] for the 2nd extraction.

These results can be a reference for the extraction of date syrups in optimal conditions; in an economical framework and good management of time and energy.

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