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Topic

Valorization of date syrup for the manufacture of Bio-chocolate

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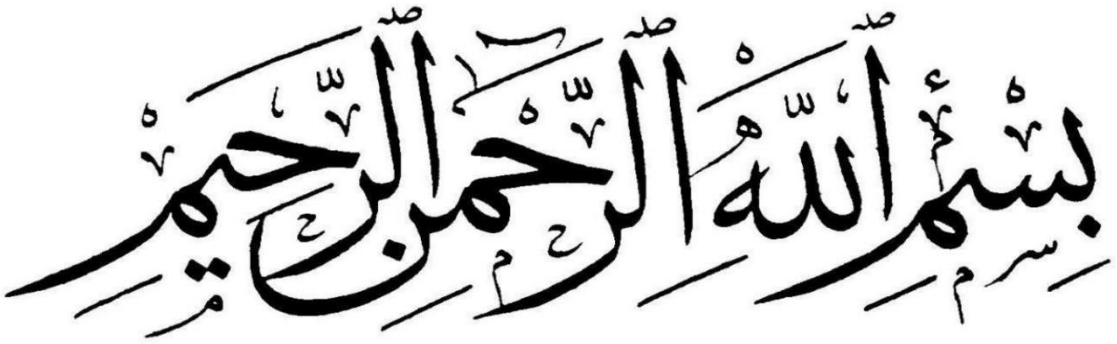

وَمِن ثَمَرَاتِ النَّخِيلِ وَالْأَعْنَابِ تَتَّخِذُونَ مِنْهُ سَكَرًا وَرِزْقًا حَسَنًا ۗ إِنَّ فِي ذَٰلِكَ لَآيَةً لِّقَوْمٍ يَعْقِلُونَ.

سورة النحل (67)

In the name of ALLAH, the Most Gracious, the Most Merciful :

And from the fruits of date-palms and grapevines, you derive sugar and wholesome food. Surely in this is a sign for people who understand.

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درصاف

Dedications

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LOUNISSA AMANI

Abstract

As health concerns such as anemia, diabetes, and obesity continue to rise, consumer preferences are shifting towards natural alternatives and embracing alternative medicine. Date syrup, derived from the fruit of the date palm (*Phoenix dactylifera* L), has emerged as one such natural alternative, valued for its nutritional richness and health benefits, particularly in arid and semi-arid regions. Its unique flavor and potential health advantages have garnered attention in the food industry.

This study aims to investigate the feasibility of using date syrup as a substitute for refined sugar in the production of organic chocolate and related products. The research will delve into incorporating date syrup into organic chocolate formulations, assessing various aspects including microbiological, physicochemical, sensory, and rheological properties of the resulting chocolate, in comparison to conventional chocolate sweetened with refined sugar. Additionally, it seeks to gauge consumer acceptance of organic chocolate enriched with date syrup.

The anticipated outcomes of this research are twofold: firstly, to contribute to the development of novel recipes of organic chocolate utilizing date syrup as a natural sweetener, and secondly, to deepen our understanding of its implications on quality attributes and consumer preferences for organic chocolate.

Keywords: date syrup, organic chocolate, food products, date palm.

Résumé

Avec l’augmentation quotidienne des problèmes de santé tels que l’anémie, le diabète et l’obésité, les préférences des consommateurs se tournent vers des alternatives naturelles et adoptent les médecines alternatives. Le sirop de datte, dérivé du fruit du palmier dattier (*Phoenix dactylifera L*), est devenu l'une de ces alternatives naturelles, appréciée pour sa richesse nutritionnelle et ses bienfaits pour la santé, en particulier dans les régions arides et semi-arides. Sa saveur unique et ses avantages potentiels pour la santé ont attiré l’attention de l’industrie alimentaire.

Cette étude vise à étudier la faisabilité de l'utilisation du sirop de dattes comme substitut au sucre raffiné dans la production de chocolat biologique et de produits connexes. La recherche portera sur l'incorporation du sirop de dattes dans les formulations de chocolat biologique, en évaluant divers aspects, notamment les propriétés microbiologiques, physicochimiques, sensorielles et rhéologiques du chocolat obtenu, par rapport au chocolat conventionnel sucré avec du sucre raffiné. De plus, il cherche à évaluer l'acceptation par les consommateurs du chocolat biologique enrichi en sirop de dattes.

Les résultats attendus de cette recherche sont doubles : premièrement, contribuer au développement de nouvelles recettes de chocolat biologique utilisant le sirop de dattes comme édulcorant naturel, et deuxièmement, approfondir notre compréhension de ses implications sur les attributs de qualité et les préférences des consommateurs pour le chocolat biologique.

Mots clés : sirop de dattes, chocolat organique, produits alimentaires, palm dattier

الملخص

مع استمرار المخاوف الصحية مثل فقر الدم والسكري والسمنة في الارتفاع ، تتحول تفضيلات المستهلك نحو البدائل الطبيعية وتبني الطب البديل. برز شراب التمر ، المشتق من ثمار نخيل التمر (*Phoenix dactylifera L*) ، كبديل طبيعي من هذا القبيل ، يقدر بثرائه الغذائي وفوائده الصحية ، لا سيما في المناطق القاحلة وشبه القاحلة. اكتسبت نكهته الفريدة ومزاياه الصحية المحتملة الاهتمام في صناعة المواد الغذائية.

تهدف هذه الدراسة إلى التحقيق في جدوى استخدام شراب التمر كبديل للسكر المكرر في إنتاج الشوكولاتة العضوية والمنتجات ذات الصلة. سيتعمق البحث في دمج شراب التمر في تركيبات الشوكولاتة العضوية, تقييم الجوانب المختلفة بما في ذلك الميكروبيولوجية, الفيزيائية الكيميائية, الحسية, والخصائص الريولوجية للشوكولاتة الناتجة, بالمقارنة مع الشوكولاتة التقليدية المحلاة بالسكر المكرر. بالإضافة إلى انه يسعى إلى قياس قبول المستهلك للشوكولاتة العضوية المخصبة بشراب التمر.

النتائج المتوقعة لهذا البحث ذات شقين: أولا, للمساهمة في تطوير وصفات جديدة للشوكولاتة العضوية باستخدام شراب التمر كمحلي طبيعي, وثانيا, لتعميق فهمنا لآثارها على سمات الجودة وتفضيلات المستهلك للشوكولاتة العضوية.

الكلمات المفتاحية: شراب التمر ، شوكولاطة عضوية ، منتجات غذائية ، نخيل التمر.

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List of abbreviations

°Bx: Degree BRIX.

°C : Degree Celsius.

pH : Potentiel Hydrogène

ABS: Absent.

PCA: Plat Count Ager

UFC: Colony-forming unit

FAO: Food and Agriculture Organization of the United Nations.

GC-MS: Gas chromatography–mass spectrometry

Introduction

Introduction

The date palm belongs to the *Arecaceae* family, a group of monocotyledonous plants classified under Angiosperms **(Farag, 2016)**. This diverse Arecaceae family comprises over 2500 species and 200 genera, among them is the *Phoenix dactylifera* L, wich is exist globally, especially in hot and humid regions. It constitutes an essential part of the daily diet worldwide with beneficial nutritional, historical significance, cultivation practices, economic importance, and health benefits **(Al-Karmadi and Okoh, 2024)**.

Since a long time, dates are known for their nutritional, functional, bioactive **(Hamad et *al*., 2015)**, therapeutic and economic values **(Taïbi et *al*., 2020)**. The date fruits constitute a rich source of carbohydrates, proteins, lipids, dietary fibers, vitamins, minerals and several bioactive compounds **(Hossain et *al*., 2014)**. They are consumed directly, as fresh or dried fruits, or transformed to vinegar, jamp, paste and syrup, especially fruits from date varieties of low commercial values.

In addition, due to the richness of dates in phytochemicals such as flavonoids, carotenoids and phenols, dates and their derivatives are endowed with many biological activities including antimicrobial, antioxidant, anti-inflammatory, antidiabetic, anticancer, etc. **(Khalid et *al*., 2017; Idowu et *al*., 2020)**.

The Algerian oases are characterized by a large genetic diversity of the date palm composed of thousand cultivars **(Bedjaoui and Benbouza, 2020)**, that have been listed and distinguished according to various morphological and physicochemical characteristics covering nearly 170.082 ha in 2019 **(FAOSTAT, 2021)**. This allowed Algeria to rank fourth worldwide in 2019 after Egypt, Saudi Arabia and Iran with an annual production of dates estimated at 1136.025 tons **(FAOSTAT, 2021)**.

In today's increasingly sustainability-focused endeavors, the unassuming date fruit has captured the attention of researchers and food enthusiasts alike **(Al-Karmadi and Okoh, 2024)**.

Moreover, despite the wealth it brings to desert areas, the phoeniculture sector is lagging behind technologically. In fact, when it comes to date technology and processing, the systems in use are still archaic. However, there has been an evolution in the eating habits of date-growing countries, and in the various uses to which dates are put. This leads us to seek the best means of responding to this evolution with a view to maximizing the value of this raw material through the development of various food and non-food formulations **(Boubekri, 2010)**.

Date syrup is a product of high nutritional value, it is rich in carbohydrates, mineral salts, vitamins and antioxidants, which are considered beneficial for human health, as they decrease the risk of degenerative diseases and certain types of cancers **(Allouache and Announ, 2018)**.

In this context, we propose the development of date-based syrups (artisanal and commercial) using a biotechnological method based on low-value cultivars. The objective is to contribute to the enhancement of this phoenicultural heritage and the innovation of a dietary product by characterizing the phytochemical compounds transferred by the raw material from which they are derived. As the manufacture of a food preparation-based Rob: chocolate.

The objective of this study is to evaluate the microbiological and physicochemical quality of two variants of date syrup: traditional and industrialized. This evaluation includes the identification of microorganisms responsible for food-borne diseases and indicators of food quality and hygiene.

This research comprises of two complementary parts. The first part is a bibliographical study, comprising two chapters. The first chapter presents an overview of date palms and dates, as well as the valorization of dates. The second chapter presents a general overview of date syrup.

The subsequent segment is experimental, and outlines the apparatus utilized, and the methods for carrying out physicochemical and microbiological analyses of date syrup and chocolate. Additionally, it describes the development of a Rob-based food product, namely chocolate, as well as sensory evaluations to delineate the organoleptic profiles of both syrups and chocolate. Furthermore, this section presents the findings, and subsequent discussions, offering comparisons with existing research.

Finally, a general conclusion summarizes the various findings and outlines the future prospects of this study.

Literature review

Chapter 1: Date palm

I.1 Date palm generalities

The date palm was named "*Phoenix dactylifera L*" by LINNEE in 1734. The term "Phoenix" comes from "phoinix", the name of the date palm among the ancient Greeks who considered it the tree of the Phoenicians; The term "dactylifera" refers to the finger ("dactylus" in latin, deriving from "dachel" in Hebrew) due to the shape of the fruits, and to fero, "which bears" in latin **(Muriel Gros-Balthazard et *al.*, 2013)**.

Date palm is a monocotyledonous, dioecious, perennial tree, that belongs to the family of Arecaceae. It has a long history of cultivation and utilization in North Africa, and the Middle East and is highly valued worldwide. This plant has immense socioeconomic, environmental, and ecological values, particularly in the arid and semi-arid regions of the world. It also has several other nutritional and health benefits that have triggered a lot of biotechnological research about its propagation, improvement, and preservation (**Walid et *al.*, 2012**).

Date palm fruits require high temperatures and low humidity to grow. Both fresh and dried date fruit can be eatable. The structure of date fruit is an epicarp, mesocarp, endocarp, and seed. There are five stages of ripening of dates which are Hanabuak, Kimri, Khalal, Rutab, and Tamr stage **(Ghnimi *et al.*, 2017)**.

Figure 1: *Phoenix dactylifera L* **(Bouguera et *al.*, 2003)**.

I.2. Classification of date palm

Date palm species classification is important for various agricultural and economic purposes, but it is challenging to perform based on images of date palms alone. Existing methods rely on fruit characteristics, which may not be always visible or present **(Haider et *al.*, 2012)**.

According to **Munier (1973)**, the classification of the date palm is as follows:

- Division : Phanerogams
- Sub-division: Angiosperms
- Class: Monocots
- Group: Phoenocoides
- Family: Arecaceae
- Subfamily: Coryphideae
- Genus: *Phoenix*
- Species : *Phoenix dactylifera L*

The date palm is one of the most important members of the palmaceae family **(Moulay Hassan Sedra, 2003)**. There are 14 other species of the genus 'Phoenix' in the tropical, and subtropical regions of the old world **(Figure 2) (Muriel Gros-Balthazard et *al.*, 2013)**.

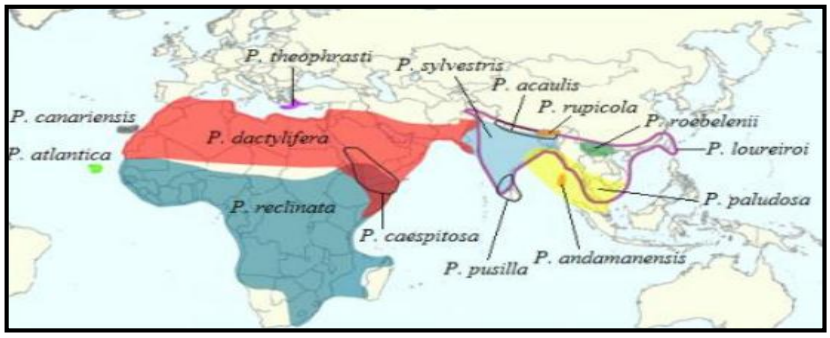


Figure 2: Distribution map of the genus Phoenix **(Muriel Gros-Balthazard et *al.*, 2013)**.

I.3. Date palm production and geographical distribution:

I.3.1. In the world

Date palm fruit (*Phoenix dactylifera* L.), is an endemic functional food with great nutritional, and economic importance due to its phytochemical composition **(Al Alawi et *al.*, 2020)**.

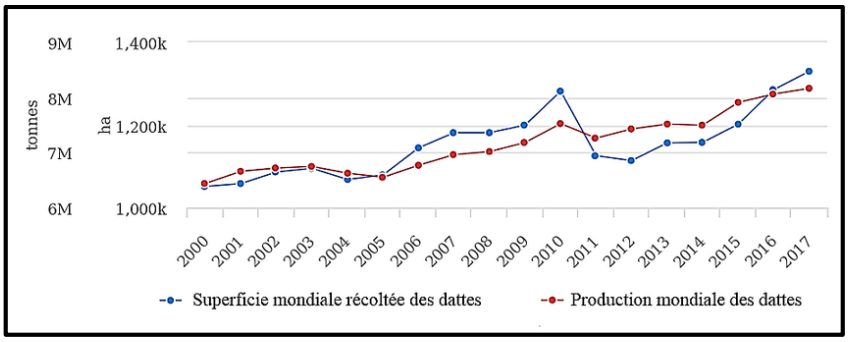


Figure 3: Global evolution and production of dates between 2000 and 2017 **(FAO, 2019).**

Date palm trees count for more than 120 million trees worldwide, and cover an area of around 250 000 ha. Each tree grows for at least 100 years, producing fruits and waste residues on annual harvests **(Awad et *al*., 2020)**. They are distributed on all continents and cultivated in many countries including "Middle East, North Africa, Central and South America, Southern Europe, Iraq, Iran, Saudi Arabia, Algeria, Egypt, Tunisia, Libya, Morocco, Sudan, Oman, and some parts of India, and Pakistan" **(Qadir et *al*., 2020)**.

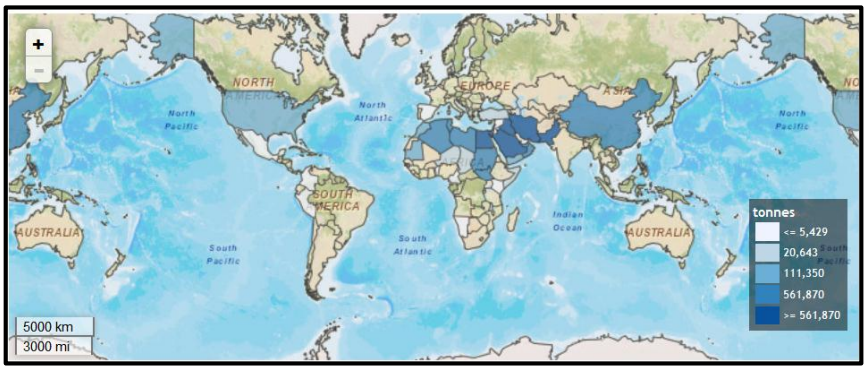


Figure 4: Distribution of date palm **(FAO, 2014)**.

I.3.2. In Algeria

The date is considered the emblematic food of the Saharan population so far; its subsistence economic value is inexpensive, and easily stored by drying and used as complementary food throughout the year.

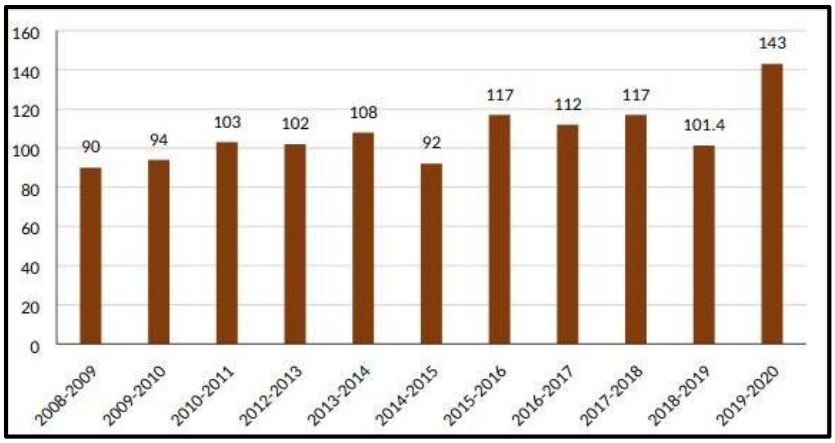


Figure 5: Evolution and production of dates palm in Algeria according to **MAPM(2020)**.

Date palm is grown in numerous oases spread in southern Algeria, where the climate is hot and dry. Given the geography of the country, it is possible to describe several regions of their cultivation as described by **Bouguedoura et *al*., (2015)**:

• In the Atlas Mountains foothills (Ksour Ouled Naïl, Zibans and Aures), there is an oasis chain that marks the gateway of the Sahara.

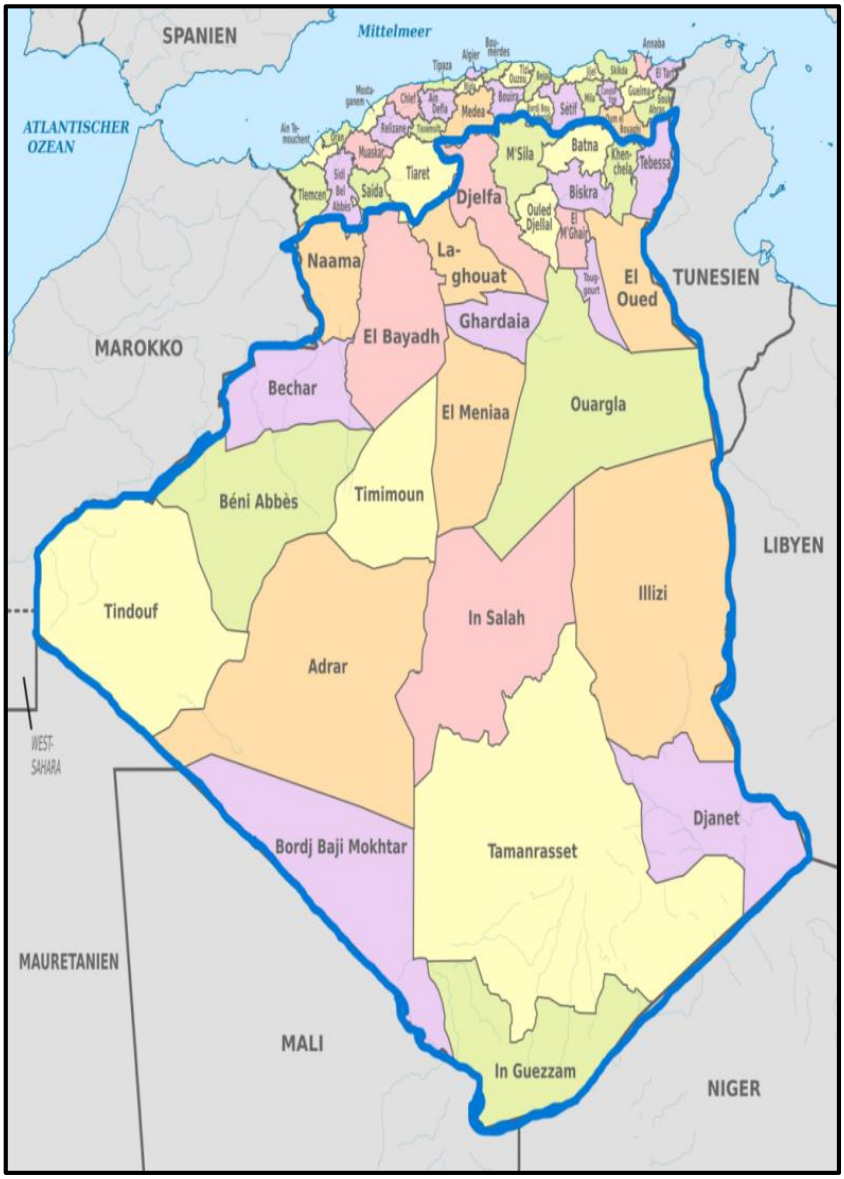
• In the east, Zibans (Biskra), Oued Righ, Oued Souf (El Oued), and the basin of Ouargla especially with deglet noor cultivar of high commercial value.

• In the west, Saoura (Beni Abbes), Touat (Adrar), Gourara (Timimoun), and Tidikelt (Reggane) where palm groves include cultivars of relatively low commercial quality. It is in this area where the only truly bayoud-resistant cultivar, Taqerbucht, exists.

• At the center, El Golea, the M'zab (Ghardaïa), and Laghouat.

The date palm in Algeria is scattered at the level of 17 towns. The territory occupied by the date palm was 167,663 hectares in 2017 **(FAO, 2017)**. The largest area is found in the towns of Biskra, and El-Oued competent both 53,533 ha, or 52%, or more than 1/2 of the total space occupied by the date palm.

Table 1: Distribution of date palm in the regions of Algeria **(DSA Biskra, 2016)**.



Code de Towns	Town
1	Adrar
3	Laghouat
5	Batna
7	Biskra
8	Bechar
11	Tamanrasset
12	Tebassa
17	Djalfa
28	M'sila
30	Ouargla
32	El bayadh
33	Illizi
37	Tindouf
39	El oued
40	Khenchla
45	Naama
47	Ghardaia

Figure 6: Geographical distribution of date palm in Algeria **(DSA Bikra, 2016)**.

I.4. Dates

The fruit of date palm **(*Phoenix dactylifera* L)** has been a fundamental food source for over 6000 years, especially in arid, and semi-arid regions like the Arab countries in the Middle East and North Africa **(Ashraf and Hamidi- Esfahani, 2011; Khwaldia et *al*., 2023)**.

Date fruits have enormous scope and potential for use as food because of their nutritional, and economical value **(Khan and Khan, 2019)**. The fruiting stage starts after 5 years and continues for up to 60 years with an average yield of 400–600 kg/tree annually. **(AlShwyeh and Almahasheer, 2022)**.

The cultural and religious significance of date fruits, especially within the Muslim community, cannot be overstated. The Holy Quran contains numerous references to the date palm **(Roumani et *al*., 2024)**.

The Prophet has likened the date palm to the believer, but he has also encouraged eating date in Islam for their health benefits. In the Prophet's wisdom, he knew that eating dates in Islam would help the well-being of Muslims everywhere. He was reported to have said, ***"He who eats seven Ajwa dates every morning, will not be affected by poison or magic on the day he eats them."*** [Bukhari].

I.4.1. Date description

Botanically, dates are drupe fruits, belonging to the family *Arecaceae* (**AlShwyeh and Almahasheer, 2022)**.

The dates, the fruit of the date palm, exhibit a wide range of colors, from golden yellow to dark red, nearly black. Additionally, their appearance, shape, consistency, size, and chemical composition vary considerably, depending on varietal differences, climate, soil, and growing conditions **(Al-Yahyai and Al-Kharusi, 2012)**.

According to **Ben Abbes (2011)**, the date is the fruit of the date palm and is an elongated, oblong or rounded berry.

Regarding the morphological characteristics (fruit and seed). The date fruit weight ranges from about 2–60 g, with lengths from 3 to 11 cm and diameters from 2 to 3 cm **(Ghnimi et *al*., 2017)**. The mesocarp, an edible part, also known as the pulp which represents the biggest part the of fruit, is fleshy, formed by parenchymatous cells. It is divided into outer mesocarp and inner mesocarp and it is protected by the pericarp (the fruit skin) **(Martín-Sánchez, 2014; Krueger et *al*., 2021)**. The date seed, an inedible part (also called kernel, pit, or pyrene) presents a furrow and small hole (micropyle), whose characteristics, depth and position depend on the cultivar. Seed weights between 0.5–4.0g, lengths between 2.3–3.6 cm and diameters between 0.6–1.3 cm have been reported.

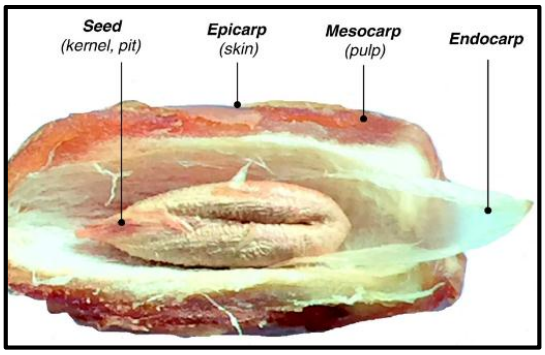


Figure 7: The anatomy of the date fruit at Tamr stage showing the epicarp, mesocarp, endocarp, and seed. **(Ghnimi et *al*., 2017)**.

I.4.2. Dates classification

According to **Espiard (2002)**, the consistency of the date is variable. According to this characteristic (**figure 8)**, dates are divided into three categories:

- **Dry dates**: hard, with less than 20% humidity, rich in sucrose. They are floury in texture such as: Degla-Beida, Mech-Degla.
- **Soft dates**: humidity level greater than or equal to 30%, they are based on invert sugars (fructose, glucose) such as: Ghars, Litima.
- **Semi-soft dates**: 20 to 30% humidity such as: Deglet-Nour, Hamraia.

Figure 8: Classificaion of dates **(Espiard, 2002)**.

I.4.3. Different stages of date evolution

According to **Amira et *al*., (2011)**, date fruits pass through several stages of maturity, traditionally described by changes in color, texture, and taste/flavor.

Nutritional and phytochemical properties of date fruit vary depending upon the harvest stage, variety, and preparation treatment **(Hussain et *al*., 2020)**. The fruit development stages of dates can be described as follows:

1. Hababouk stage: It is the initial stage that starts after fertilization and lasts for 4–5 weeks, with 80–90% moisture.

2. Kimri stage: During this stage, the fruit increases in length, weight, sugar levels, and acidity. This stage ends with a change in fruit color to yellow or red (depending upon the variety involved).

3. Khalal stage: At this stage, the fruit starts to turn from green to yellow purplish-pink, red or yellow scarlet (depending on variety). The glucose content increases while the moisture content decreases up to 50%. The tannins start to precipitate and lose their astringency, making the dates more palatable.

4. Rutab stage: Sucrose changes into invert sugars with less tannin than the previous stage and moisture contents decreases to 35–40%. The dates become soft, half-ripe and turn light brown in color.

5.Tamar stage: At this stage, the invert becomes the predominant sugar in the fruit. The dates become soft with 20–25% moisture content.

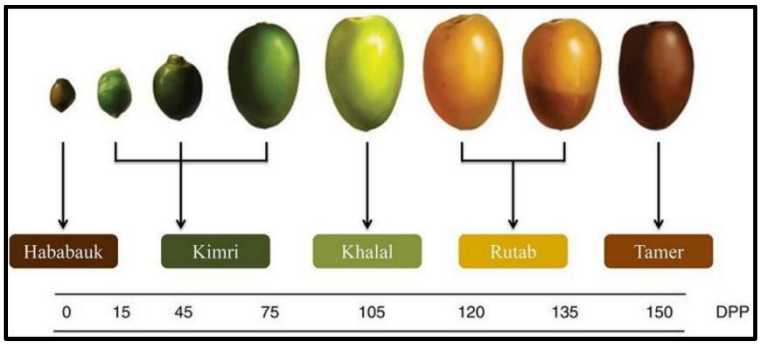


Figure 9: The five growth stages of a date fruit by days post pollination (DPP) **(1)**.

I.4.4. The biochemical composition of the date

Dates are a food composed of a mixture of macro- and micro-elements, with varying levels **(Sawaya et *al*., 1982).**

Following the findings of **Estanove (1990)**, dates are primarily composed of water, the reducing sugars glucose and fructose, and the non-reducing sugars sucrose. Additionally, they contain non-carbohydrate constituents, including proteins, lipids, cellulose, ash (mineral salts), vitamins, and enzymes.

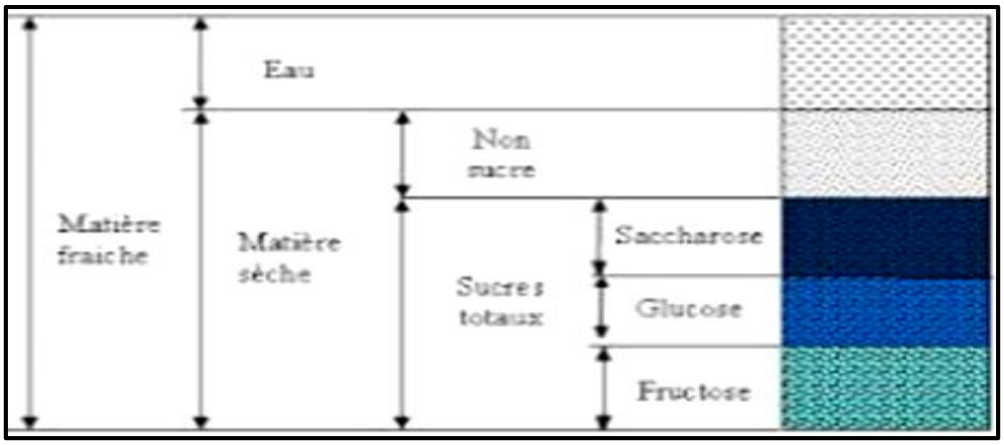


Figure 10: Composition of dates **(Estanove,1990; Djennane and Atia, 2012)**.

The date is made up of two parts, one edible, represented by the pulp or flesh (mesocarp), and the other inedible, the stone, which has a hard consistency.

I.4.4.1. The biochemical composition of the edible "pulp" part

I.4.4.1.1. Principal components

1. Water

In general, dates have a moisture content of less than 40%. They are classified among foods with intermediate humidity whose conservation is relatively straightforward **(Bessas, 2007)**.

2. Sugars

The study conducted by **Reynes et *al*., (1996)**, found that dates contain three major sugars: sucrose, glucose, and fructose. However, this does not rule out the presence of other sugars such as galactose, xylose, and arabinose. Glucose and fructose (reducing sugars), which are likely to have been produced by inversion, are present at different levels in a large number of date varieties (**Hadjari and Kadi hnifi, 2005)**.

The hydrolysis reaction is simplified by the formula:

$$C_{12}H_{22}O_{11} + H_2O \rightleftharpoons C_6H_{12}O_6 + C_6H_{12}O_6$$

Sucrose + water ⇌ Glucose + Fructose

The total sugar content, as well as the proportion of reducing sugars and sucrose, varies according to variety, within the limits of 50 to 85% for total sugars and 20 to 60% of the pulp weight in reducing sugars **(Bennamia and Messaoudi, 2006)**.

3. Pectin and cellulose

For all cultivars, date pulps have a fibre content (cellulose and pectin) of 4.5%. The soluble pectin content is 1.21%, 0.67%, and 0.51% respectively for the date, stone and pulp, which also contain 1.66%, 3.12% and 2.65% crude pectin acid and 0.77% total pectin **(Bessas, 2007)**.

4. Amino acids and proteins

Dates are a low-protein food representing 1.1 to 2.6% of dry weight **(Yahiaoui, 1998; Parvin et *al*., 2015; Assirey, 2015)**.

Table 2: Average amino acid composition of dry dates **(Favier et *al*., 1993)**.

Amino acids	Pulp content in mg/100g
Isoleucine	64
Leucine	103
Lysine	72
Methionine	25
Cystine	51
Phenylalanine	70
Tyrosine	26
Tryptophan	69
Valine	88
Arginine	68
Histidine	36
Alanine	130
Aspartic acid	174
Glutamic acid	258
Glycocoll	130
Proline	144

Serine	88

5. Fat

The fat percentage in date pulp is relatively low, ranging from 0.3 to 1.9% of a fruit fresh weight. Most of this fat is found in the fruit skin, in the form of wax **(Shehata, 2000)**. Fat is practically absent in the pulp, which contains less than 0.5% dry matter (**Boukhiar, 2009)**.

6. Fibre:

A significant proportion of these compounds are insoluble, consisting mainly of cellulose. Fine dates, such as Deglet-Nour, contain only a small proportion of this substance, but higher proportions, sometimes reaching over 10% in the case of particularly fibrous common dates **(Meunier, 1973).**

According to **Bonaz et *al*., (2007)**, an increased consumption of refined sugars, and a reduced consumption of fibre, vitamins, minerals, and essential fatty acids may play a role in cryptogenetic inflammatory bowel diseases.

7. Minerals

The most remarkable feature of dates is the presence of particularly abundant minerals, and trace elements, which clearly outstrip other dried fruits **(Al Juhaimi et *al*., 2014)**.

8. Vitamins

The pulp of the date fruit is a rich source of vitamins in varying quantities, including retinol, riboflavin, thiamine, niacin, thiamine, niacin, pyridoxine, folic acid, and ascorbic acid. These vitamins are essential for the body **(Saafi et *al*., 2008; Al-Farsi and Lee, 2008; El-Sohaimy, 2010; Abdu, 2011)**.

In general, it contains significant quantities of carotenoids, and group B vitamins, but little vitamin C **(Meunier, 1973)**.

Table 3: The composition of various minerals and vitamins in date pulp **(Benchelah and Maka, 2008)**.

Minerals		Vitamins	
Potassium	670 to 750 mg	B3	1,7 mg
Calcium	62 to 65 mg	B5	0,8 mg
Magnesium	58 to 68 mg	B2	0,10 mg
Iron	3 mg	B6	1,15 mg
Phosphorus	3 mg	Reported PP vitamins	0,03 mg
Copper	3 mg	provitamins A	
Zinc	3 mg	Vitamin C	The compound is present in small quantities in fresh date but almost entirely absent in dried dates
Manganese	3 mg		
sodium	1 to 3 mg		
		.	

9. Enzymes

Enzymes play a pivotal role in the biochemical conversion process that occurs during the formation, and ripening of fruit. The quality of dates is influenced by the activity of the following enzymes:

- Invertase is responsible for the inversion of sucrose into fructose and glucose.
- Cellulase: This enzyme breaks down cellulose into shorter chains.
- Pectin methylesterase: is responsible for the conversion of insoluble pectic substances into more soluble pectin, which softens the fruit.
- Polyphenoloxidase is responsible for the browning of the fruit following the oxidation of phenols **(Yahiaoui, 1998)**.

10. Polyphenols

- **Tannins**

These account for more than 3 % of the date weight and one of the main effects of tannins is their impact on the ripening process. Tannins also play a role in non-enzymatic browning **(Maier et *al*., 1964**), which is why heat treatments are employed to delay browning during storage.

- **Flavones**

Are essentially involved in the enzymatic browning that is responsible for the coloring of the date during ripening **(Cheftel et *al*., 1977; Barreveld, 1993)**.

11.Pigments

The pigments identified in dates are carotenoids, anthocyanins, flavones, flavonols, lycopene, carotenes, flavoxanthin, and lutein in certain varieties. The anthocyanins with carotenes are responsible for the red color of Deglet-Nour at the bser stage **(Bousdira, 2007)**.

I.4.4.1.2 Minor components

Although 95% of date components are represented by the compounds listed above, other less important compounds influence the quality of the fruit. These include organic acids (citric acid, malic acid, etc.), and volatile substances analyzed by GC-MS, of which ethanol, iso-butanol and iso-pentanol are the main components. In addition to carotenoids, chlorophyll is revealed in the early stages **(Benchabane, 1996)**.

I.4.4.2 The biochemical composition of the non-edible component, the "stone"

Represents a range of 7 to 30% of the date's weight. The composition of the non-edible part, the "stone", is comprised of white, hard, and horny albumen, which is protected by a cellulose envelope **(Espiard, 2002)**.

Research into the composition of the pits of certain varieties of Saudi Arabian dates has revealed the presence of a range of nutrients, including proteins, carbohydrates, lipids, and minerals (potassium, phosphorus, calcium, sodium, iron, manganese, zinc, and copper). In addition to proteins, the kernel contains fatty acids **(Benabbes, 2011)**.

In addition to proteins, the kernel contains a range of fatty acids, including oleic, psalmic, lauric, linoleic, and palmitic acid. These are all found in the oil extracted from the seeds **(Al houti et *al*., 1998)**.

Table 4: Biochemical composition of Iraqi date pits **(Munier, 1973)**.

Constituents	content%
Water	6.46
Carbohydrates	62.51
Protein	5.22
Lipids	8.49
Cellulose	16.20
Ash	1.12

I.4.5. Nutritional value of dates

Date flesh is found to be low in fat and protein but rich in sugars, mainly fructose and glucose. It is a high source of energy, as 100g of flesh can provide an average of 314 kcal. Ten minerals were reported, the major being selenium, copper, potassium, and magnesium.

The consumption of 100g of dates can provide over 15% of the recommended daily allowance from these minerals. Vitamins B-complex and C are the major vitamins in dates. High in dietary fiber (8.0g/100g), insoluble dietary fiber was the major fraction of dietary fiber in dates. Dates are a good source of antioxidants, mainly carotenoids and phenolics.

Date seeds contain higher protein (5.1g/100g) and fat (9.0g/100g) as compared to the flesh. It is also high in dietary fiber (73.1g/100g), phenolics (3942mg/100g) and antioxidants (80400µ mol/100g).

This detailed information on nutritional and health promoting components of dates and their seeds will enhance our knowledge and appreciation for the use of dates in our daily diet and their seeds as a functional food ingredient **(Al-Farsi et *al*., 2008)**.

Table 5: Nutritional value of dates **(Boukhiar, 2009)**.

	Pitted dried date 25g (3 small fruits)	Fresh pitted Medjool date , 1 large fruit , 24g
Calories	70	66
Protein	0,6 g	0,4g
Carbohydrates	18,7g	18,0g
Lipids	0,1g	0,0g
Dietary Fiber	2,0g	1,6g
Glycemic load	Strong	
Antioxidant power	Very higy	

I.4.6. Valorization of date

It is an ideal substrate for deriving a range of added-value products in food and nutraceutical industries in the coming future, employing bioprocessing technologies, which have immense scope for application in the valorization of date by-products **(Younas et *al.*, 2020)**.

Date fruit waste is an example of agri-food waste generated in the Arab region **(Sifour et *al.*, 2017)**.

The traditional processing of dates is prevalent and practiced by the population of the Oasian regions, the expansion of this craft activity would contribute to the stimulation of new markets, and consequently the extension of the date palm sector **(Djafri et *al.*, 2020)**. According to **Harrak and Boujnah, (2012)**, two types of date processing can be distinguished:

- Technological processing: techniques based on industrial processes for date processing
- Biotechnological processing: techniques aimed at industrial applications of bioconversion.

I.4.6.1. Date syrups

It is made from dates of secondary quality, too soft or crushed, which can be used to manufacture syrup **(Benjamain et *al.*, 1985)**. They are cut and heated in water to obtain a rich syrup that can be filtered and concentrated under vacuum until a product is concentrated at 65-70 % dry matter.

The date syrup locally called «Rob», due to its high sugar content, can be consumed directly where used in different preparations either as an additive or as a substitute for sucrose in pastry, biscuit making, and for making energy drinks such as soft drinks sweetened with a mixture of date syrup **(Chouana et *al*., 2019)**.

I.4.6.2. Date jams

These products are based on the use of healthy dates to avoid the fermentation aftertaste. This range of products is based on the extraction of sugars by diffusion of these ingredients and other soluble substances to obtain creams and jams of excellent quality **(Ben abbes, 2011)**.

I.4.6.3. Date sugars

According to **Harrak and Boujnah (2012)**, sugar is obtained from grinding followed by mixing dates in hot water. It is preferable to use a diffusion process that allows the recovery of most of the sugars while limiting the diffusion of us sugars in the juice. Syrup concentration is 30 to 35 degrees, Brix at low temperature (40 to 45°C), and under vacuum. A light brown to bright yellow concentrate is obtained depending on whether it is discolored or not.

Chapter 2: Syrup date

II.1. Generalities

Date syrup, also called “date honey” “Rob AT-Tamr” (misnomer) or Dibs in the Arab world is a sweet, dark brown product extracted from dates and typical of Arab cuisine (figure 11) **(Mimouni, 2015)**.

According to **Mimouni (2009),** date syrup is a natural product made from dates, liquid, and very concentrated. Can also be used as a sweetener**.** It is very rich in nutrients, certain sugars and minerals elements (**Zuhair I et *al*., 2022)**.

These products are made from healthy dates because it is important to avoid any fermentation aftertaste **(Chibane, 2008)**.

Figure 11: Date syrup. **(2)**

II.2. Date syrup production situations

In arid regions, dates are a valuable fruit that plays an important role in the economic substance of oases. The average yield of each palm tree is about 60 kg of fruit per year, up to 100 kilograms with proper care. This yield is a crucial food source for the local population and a fundamental ingredient in various applications. The traditional know-how of Indigenous communities in the valorization and transformation of dates, whether commonly consumed or not, must be recognized and appreciated **(Boussaid, 2020)**.

II.2.1. In the world

Date syrup is just beginning to be manufactured industrially although it has long been made by Phoenician families. Iraqis interested in date technology to reduce their dependence on abroad **(Munier, 1973)**.

II.2.2. In Algeria

Date syrup is a foodstuff of some local date cultivars known locally as «Rob AT-Tamr» (improper name), or «Dibs» in the Arab world **(Mimouni, 2015)**.

The town of Biskra and El Oued account for two-thirds of the national production (62%).

II.3. Biochemical Composition of Date Syrup

In addition to sugars, date syrup contains macro- and microelements such as proteins, lipids, pectin and mineral salts **(Table 06)**, which can play an important role in considering date syrup as a complete food **(Gabsi et *al*., 2013)**.

Table 6: Chemical composition of date syrup.

Components	**(Benharzallah, And Bouhoureira, 2014)**	**(Mimouni And Siboukeur, 2011) (Ghars Variety)**
Water content	16	13.7
Soluble solids	84	86.3
Total sugars	79.45	80.73
Reducing sugars	4.87	79.96
Protein	0.83	1.15
Pectins	1.46	3.86

II.4. Properties of date syrup

II.4.1. Organoleptic properties

- **Taste**

Date syrup is characterized by a relatively sweet taste, attributed to its fructose content, which has a high sweetening power. Its flavor is reminiscent of the date from which it comes (**Entezari et *al*., 2004)**.

Most high-sweetening agents have aftertastes that overlap with the sweet taste, and result from impurities that are sometimes indefinable to the point of not being classified among the three primary tastes (salty, sour, or bitter) **(Multon and Lepatre, 1984)**.

- **Color**

According to **Abdelfattah (1990)**, date syrup can take on a reddish black color in transparent bottles. Also date syrup is a stable product with a more or less brown color.

II.4.2 Physical properties

- **Viscosity**

Viscosity is a critical physical characteristic of date syrup; it determines the storage conditions of the product. As the water content decreases, viscosity tends to increase, it is proportional to the Total Soluble Solids in the syrup, which gives it a high sweetening power. The syrup has a dry matter content of 72 to 75%, with a viscosity of 500 centipoises. It is a very viscous product; this is due to the low humidity. This property is important to preserve the quality of the product for two years, and serving as a barrier against the proliferation of microorganisms **(Abdelfattah, 1990)**.

- **Density**

The average density of a syrup depends on its concentration. The latter is inversely proportional to the ambient temperature. The density of date syrup is very high due to the level of soluble solids existing in this product, this character allows their storage for a long time **(Abdelfattah, 1990).**

II.5. The different methods of making date syrup

II.5.1. Extraction by pressing

The principle of this process is based on the compaction method, generally carried out in a canvas bag (Btana), which constitutes the means of preserving soft dates. After washing dates with water to clean the fruits, and increase the humidity level. Under the effect of the weight of the dates, temperature, and high humidity. Honey attracts, their yield is very low varying between 10 to 15% of the weight of the date, the honey obtained is a natural product with a high concentration (around 82%), carrying the smell, taste, and color of the date used **(Ibrahim and Khalil, 1997)**.

II.5.2. Low temperature water soaking process

The dates are soaked in lukewarm water for several hours. Then, the suspension was filtered to remove the fibers and nuclei. Finally, the resulting extract was subjected to heating again over a low heat, to evaporate the water, and increase its concentration. The disadvantage of this

technique lies in the fact that the juice does not always have the same concentration (lack of reproducibility). In addition, this is often low, hence the risk of fermentation **(El ogaidi, 2000)**.

II.5.3. High temperature water soaking process

This method is the most used, a recommended high temperature (up to 90°C) to allow faster extraction followed by refrigeration **(Mimouni, 2015)**. After the extract is filtered, the juice from the impurities separated from the sugar solution is sealed by "carbonization." The drink is obtained in a dark color and tastes of burned sugar

II.5.4. Diffusion process

A quality syrup with a process that requires diffusion extraction followed by a vacuum concentration to reduce caramelization and preserve the nutritional value of the syrup resulting from processing **(Djafri et *al*., 2020)**. The principle is based on the passage, according to the laws of diffusion by passive transport, the juice is then recovered after decanting and passage through a gauze.

This method is proposed as a substitute for the traditional concentration based on direct cooking.

II.5.5. Extraction with enzymes (cellulase and pectinase)

The extraction process involves the use of enzymes (cellulase and pectinase). This begins with the soaking of a date paste in water, which is then kept at a boiling point. Following filtration, the solution is subjected to an enzymatic treatment (cellulase and pectinase) for clarification **(Chikhrouhou et *al*., 2006; AL-Sharnoubi et *al*., 2014)**.

II.5.6. Microwaves extraction

The utilization of microwave technology for the extraction of date syrup can be summarized as follows **(Chikhrouhou et *al*., 2006)**:

- The pits should be removed and the dates chopped. It is advisable to remove the pits from the dates, and to chop them into smaller pieces, as this will facilitate the extraction process.
- The combination of water, and dates is a fundamental aspect of the extraction process. The chopped dates should be combined with water in a microwave-safe bowl. The ratio of water to date can be varied according to the desired consistency of the syrup.
- The mixture should be microwaved in intervals. The mixture should be heated on a medium power setting (50-70 % of the microwave's capacity) for short intervals, with intermittent breaks.

This method helps to prevent burning, and allows for more even heating. Subsequently, the mixture should be stirred after each interval.

- The straining and reduction of the mixture should be carried out. Once the dates have softened, and the liquid has been released, the mixture should be strained to separate the solids from the syrup. Subsequently, the syrup may be further reduced in the microwave oven using short intervals, and breaks, with the consistency being monitored closely to avoid burning.

II.6. Use of date syrup

Date syrup is rich in certain nutrients (sugar, phenolic compounds...); it provides a good source of fast energy due to its high sugar content. Indeed, the high sugar content should justify their use as a source of liquid sugar suitable for many food products such as the basis of drinks, bakery products, ice cream, and confectionery **(Chouana et *al*., 2019)**.

Due to the flavor effect, date syrup is used to improve the quality of fermented dairy products **(Abbes et *al*., 2015)**.

II.7. Nutritional value of date syrup

Date syrup is a product of high nutritional value, rich in date constituents such as carbohydrates, minerals, vitamins, etc.

These antioxidants reduce the risk of degenerative diseases, and certain types of cancer by reducing oxidative stress and inhibiting the oxidation of macromolecules **(Abbes et *al*., 2013)**. This product helps to combat anemia and demineralization, and is therefore recommended for breastfeeding women.

These fruits, crushed in water used to treat hemorrhoids, constipation and jaundice. Alternatively, it can be employed as a sedative in the form of a highly concentrated syrup. Furthermore, it is used for the treatment of nervous disorders and bronchopulmonary affections. Dates are efficacious in the treatment of colds. Additionally, they are efficacious in the treatment of engargarism, with the potential to cure sore throats **(Benchelah and Maka, 2008; Ben Abbas, 2011)**.

II.8. Medical benefit of date syrup

❖ Antibacterial activity

It has been demonstrated for the first time by **Taleb et *al*., (2016)** that date syrup can inhibit Gram-negative *E. coli*, and Gram-positive *S. aureus* by generating H_2O_2. Date syrup are active intermediate directly involved in inducing oxidative stress in bacteria due to hydrogen peroxide generation. These results confirm the critical relationship between antioxidants and prooxidants of date syrup in bacterial growth and inhibition.

❖ Antioxydant activity

According to all tested methods studied by **Al-Mamary et *al*., (2014)**, the antioxidant activity of all palm dates syrups was compared with that of vitamin C, which is a well-known potent antioxidant. In general, the present study reports that palm dates syrups can be a good source of natural antioxidants, which act by several mechanisms, such as removal of free radicals, scavengers of NO, OH, and H_2O_2, chelation of Fe^{2+} ion, the ability to reduce transition metals (i.e., Fe^{3+} fi Fe^{2+}), and the ability to prevent lipid peroxidation.

The scientific results obtained from this study signify that palm date fruits (or their syrups) are a very important source of natural antioxidants, which can play a very important role in reducing oxidative stress and preventing dangerous diseases, such as cancer, liver, and cardiovascular diseases.

❖ Anti-diabetic activity of date syrup

Diabetes mellitus (DM) is a disease that is universally emerging, where either reduced secretion or sensitivity of insulin is observed coupled with poor glucose control. Natural products, which are often free from side effects, are good alternatives for disease amelioration (**Alam et *al*., 2019)**. Additionally, natural products have potentially effective roles in regulating diabetes and its complications (**Solayman et *al*., 2016)**.

Syrup date is one of the natural products reported to have good potential in diabetes treatment due to its presence of polyphenols exerting strong antioxidant activities. Other possible mechanisms of action include the polyphenolic compounds, which can inhibit enzymes like α-amylase and α-glucosidase. Flavonoids in syrup dates can stimulate β-cells by increasing the number of islets, and β-cells, recovering endocrine pancreatic tissues, reducing β-cell

apoptosis, activating insulin receptors following the increase in insulin secretion, in addition to improving diabetes-induced complications.

- **Antianemia activity of date syrup**

Anemia is defined according to WHO as a pathological condition in which the hemoglobin content in the blood has become abnormally low following a deficiency of one or more essential nutrients. Anemia can be easily treated with a healthy diet (**Hioui et *al*., 2006)**.

Date syrup has great importance in the therapeutic effect of iron deficiency anemia. The first reason lies in the fact that this drink has a high bioavailability of iron and that the presence of proteins, carbohydrates and fats and elements such as Zn, Fe and Ca and the presence of abundant amounts of vitamin A contributes to the synthesis of hemoglobin to increase hemoglobin levels **(Iin K, 2016)**, red blood cell count, hematocrit and serum iron. date syrup can be classified among the foods that help fight iron deficiency anemia **(Laiche,2020)**.

Experimental study

III. Material and Methods

Our study was divided into two main parts: a physico-chemical analysis and a microbiological investigation. This experimental phase extended from February to April 2024.

For the physico-chemical analysis, our experiments were conducted within the microbiology educational laboratory of the University of May 8, 1945 - Guelma. Meanwhile, the microbiological parameters were assessed at the laboratory of the Directorate of Public Health (DSP) - Guelma. The methodology employed in both settings are detailed below.

III.1. Material and products

Table 7: The different material and products used in our analysis.

Material	**Laboratory tools:** Test tubes, petri dishes, durham bell, capsules... **Laboratory devices:** Incubator, refractometer, Muffle furnace, spectrophotometer, Stirrer...
Products	**Culture medium:** PCA, Meat Liver, sabouraud chloramphenical, Hektoen... **Nutritive both**: Selenite cysteine SFB **Reactive**: Kovac reagent **Solutions**: Sodium Hydroxyde, TSE... **Indicator**: Phenolphtalein. **Acid**: Sulphuric acid H_2 SO_4

III. 2 Physicochemical analysis

III .2.1. Determination of pH

This is the measurement of the hydrogen potential of a syrup solution using a pH meter. The pH meter is calibrated with buffer solutions at pH 4,7 and 10.

- **Operating mode**

- Measure 2.5 g of each sample and add 25ml of distilled water.

- After stirring, the pH values are measured with the multi-parameter.

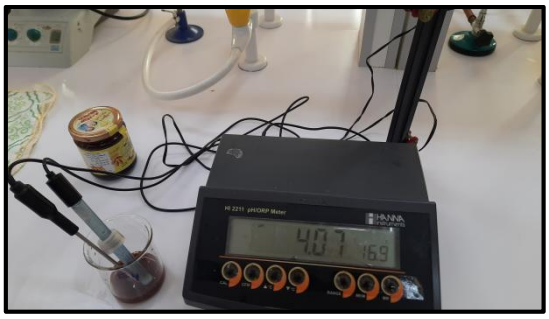


Figure 12: The measurement of the hydrogen potential by pHmeter **(personal plug)**.

III.2.2. Determination of titratable acidity

- **Principle**

Titration of the acidity of date syrups with a sodium hydroxide solution in the presence of phenolphthalein as indicator.

- **Procedure**

- 25 ml of date syrup is placed in a 50 ml beaker

- Add 50 ml of recently boiled and cooled hot distilled water, then stir until a homogeneous liquid is obtained.

- Filter the liquid into a 250 ml volumetric flask using filter paper, and make up to the mark with distilled water.

To determine the acidity, take 25 mL of the filtrate, and pour into a beaker, add two to three drops of phenolphthalein while stirring and burette the sodium hydroxide solution at N/9 until a persistent pink color is obtained for 30 sec, noting the volume of soda poured. The titratable acidity is expressed in grams of citric acid per 100 g of product:

$$A\% = (250.V1.100)/ (V0.M.10).0,06$$

M: Mass of test sample (g),
V: Volume of filtrate taken for titration (ml),
V1: Volume of 0.1 N sodium hydroxide solution used (ml),
0.06: Conversion factor of titratable acidity to acetic acid equivalent.

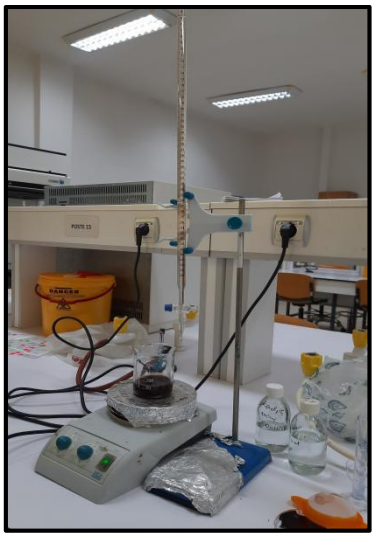


Figure 13: Equipment to measure acidity titratable **(personal plug)**.

III.2.3. Water content

The method used to determine sample moisture is to dry a test sample of the product in an oven at 103°C± 2°C until a constant weight is obtained (**Audigier et *al*., 1982)**.

- **Procedure**

Weigh empty capsules after oven-drying for 15 min at 103°C ± 2°C.

- Add 1 g of each sample to the capsules and reweigh.
- Place capsules in an oven set at 103°C ± 2ºC for 3 hours.
- The capsules are removed from the oven and weighed after cooling.
- The operation is repeated until a constant weight is obtained, reducing the duration of the operation.
- 30 min drying time to avoid caramelization.

Moisture content is calculated using the following formula:

$$H\%=(M1-M2)/P.100$$

Or:

H %: Humidity.

M1: Mass of capsule containing fresh material before steaming (g).

M2: Mass of capsule containing fresh material after steaming (g).

P: Weight of test sample (g).

The dry matter content is calculated as follows:

MS% = 100 - H %

III.2.4. Soluble solids content (TSS or °Brix)

A drop of date syrup was placed on the refractometer plate, which had been cleaned with distilled water. The Brix degree was read directly on the scale at the intersection of the boundary between the light, and dark fringe **(Doukani and Tabak, 2014)**. The refractometer is thermostatically controlled, which allows direct reading of the refractive index (RI), and Brix degree **(Mimouni, 2015)**. The measurement of Brix degree is strongly linked to temperature as it has an influence on refractive index.

Figure 14: The refractometer for Brix measurement **(personal plug)**.

III.2.5. Ash content

Ash is the residue of mineral compounds that remains after incineration of a sample containing organic substances **(AFNOR, 1977)**. Estimating total ash enables us to judge the mineral content of a product. In fact, ash determination is based on the destruction of all organic matter under the effect of high temperature (500±25°C). Place a test batch of date syrup in a muffle furnace for 30 min at 500°C. On leaving the oven, until the weight becomes constant (white or greyish-white in color), place the samples in a desiccator for cooling. Weigh the cooled capsules **(Doukani and Tabak, 2014)**.

Organic matter is calculated primarily by the following formula:

$$MO\% = \frac{M1-M2}{P} \times 100$$

With:

MO: Organic matter.

M1: Mass of capsule + the test sample

M2: Mass of capsule + ashes.

P: Weight of test intake.

The ash content is calculated as follows:

Ash (%) = 100 - **MO**%

Figure 15: A muffle furnace **(personal plug)**.

III.2.6. Determination of total sugar content

- Add to 0,125 g of sample 5 ml of sulphuric acid (H_2S0_4) 0,5 M.

The assembly is then placed in an oven set at 105°C for 3 hours.

- Transverse the solution in a 500 ml vial while adjusting the volume by distilled water up to 500ml.

- After filtration of the solution, three 1/3 dilutions were carried out.

- In tubes, 1ml of each dilution is added, then in each tube 1ml phenol 5 % and 5ml sulfuric acid H_2S0_4 98 %.

- Tubes are held in oven for 5 minutes at 105°C, then left in darkness for 30 minutes.

- Finally, the optical density is read with a spectrophotometer at a wavelength of 485 nm **(Dubois and *al*., 1956)**.

III.3 Microbiological analyses

Microbiological analyses were conducted in strict adherence to Algerian regulations governing the microbiological quality of semi-preserved products of vegetable origin **(JORAPD n°39, 2017)**.

For this experiment, we utilized a total of five samples: two sourced from industrial production and two from traditional methods of date syrup extraction. The fifth sample was derived from organic chocolate crafted using date syrup as a primary ingredient.

III.3.1. Preparation of stock solution and decimal dilutions

In sterile conditions, each sample (stock solution) is introduced using a graduated and sterile glass pipette into a sterile screw tube containing beforehand 9ml of diluent or EPT (buffered peptone water), this dilution corresponds to 1/10 or 10^{-1}, then homogenize the solution with the vortex for 5-10 seconds. Subsequently, 10^{-1} dilution is introduced aseptically using a 1mL sterile graduated glass pipette into a 9mL tube of the same sterile diluent (TSE) solution, then the solution is homogenized with the vortex for 5 to 10 seconds, this dilution corresponds to 10^{-2}. This is followed from 10^{-3} until dilution 10^{-5} is obtained. Stirring is carried out until the last dilution and a new pipette is renewed for each new dilution.

III.3.2. Total aerobic mesophilic flores (FMAT) research and enumeration

Aerobic mesophilic flora (FMAT) refers to aerobic microorganisms that develop at a temperature of 30°C. FMAT research is conducted on the Plate Count Agar (PCA) culture medium.

Incubation is performed at 30°C for 24 h to 72 h.

- **Operating mode**

From the stock solution to be analysed or these dilutions (10^{-2}, 10^{-3}), aseptically carry 1ml in empty petri dishes, numbered;

- Add about 15 ml of melted PCA agar and cool to 45°C±2°C.

- Make circular and back-and-forth movements in the shape of “8” to allow the inoculum to mix with the agar, on a fresh, horizontal surface.

- Let solidify the petri dishes on a bench.

- Incubation is at 37°C for 48 hours.

- **Reading and interpreting**

The FMAT colonies appear in mass in lenticular and distinct forms **(Fig. 16)**

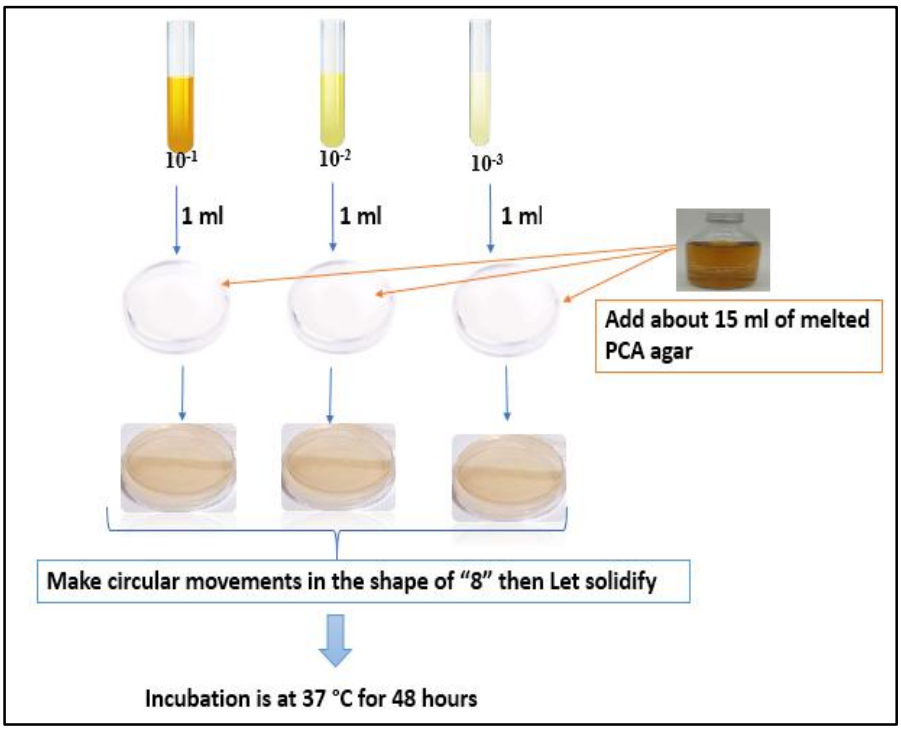


Figure 16: Search and enumeration of total flora **(personal plug)**.

III.3.3. Coliform Research and Enumeration

Coliforms are Gram-negative, aerobic or anaerobic bacilli, optional, non-sporulated, free of oxidase, capable of multiplying in the presence of bile salts and capable of fermenting lactose with acid and gas production in 24 to 48 hours at a temperature between 36 and 37°C **(Delarras and Trébaol, 2003)**.

Fecal coliforms, or thermo-tolerant coliforms, are a subgroup of total coliforms capable of fermenting lactose at a temperature of 44°C. The species most frequently associated with this bacterial group is Escherichia coli, to a lesser extent, certain species of the genus *Citrobacter*, *Enterobacter* and *Klebsiella*. *Escherichia coli* are thermo-tolerant coliforms that produce indole from tryptophan in the medium at a temperature close to 42°C±2°C **(Bourgeois and Leveau, 1980)**.

- **Operating mode**

The search and enumeration of coliforms and the identification of *E. coli* were carried out by the method of three tubes of the most probable number (NPP) also called colimetry. This method is a statistical estimate of the number of microorganisms assumed to be disseminated in the sample in a perfectly random manner **(Rejsek, 2002)**.

This technique is done in two consecutive steps:

The presumptive test: Reserved for the search for coliforms

Confirmatory testing: only for fecal coliforms and *E. coli*.

- **1st step: Presumptive test**

- It is carried out using (BGBB)
- All tubes are equipped with a Durham bell to detect any gas in the medium.
- Before sowing the tubes, check that there is no air bubble under the bell, to avoid distorting the results.
- From the dilutions of the solutions, it is necessary to prepare aseptically:
- 03 times 10 ml in 3 tubes containing 10 ml medium (BGBB).
- 03 times 1 ml in 3 tubes containing 10 ml of medium (BGBB).
- 03 times 0.1 ml in 3 tubes containing 10 ml of medium (BGBB).
- Remove any air present in the Durham bells and mix the medium and inoculum well.
- This time, the incubator incubates at 37°C for 24 to 48 hours.
- Will be considered positive, the tubes having at the same time: a gas release (greater than 1/10 of the height of the bell) and a microbial disorder accompanied by a turn from the middle to the yellow (which is the witness of the fermentation of lactose present in the medium). These two characters are witnesses of lactose fermentation in the described operating condition.

- **2nd step: Confirmative test (Mac Kenzie test)**

The confirmatory test is based on the search for thermo-tolerant coliforms among which the presence of Escherichia coli is especially feared. (BGBB) tubes found positive during coliform

enumeration will be transplanted using a loop in a tube containing the indole-free peptone water medium

This time, the incubator incubates at 44°C for 24 hours. Tubes with both:

- A red ring on the surface, showing indole production by *Escherichia coli* after addition of 2 to 3 drops of the Kovacs reagent **(Fig 17)**.

The final reading is also done according to the prescription of the NPP table since fecal coliforms are part of the total coliforms, it is impossible to find more fecal coliforms than total coliforms. The results are expressed in germs per gram of the analyzed product.

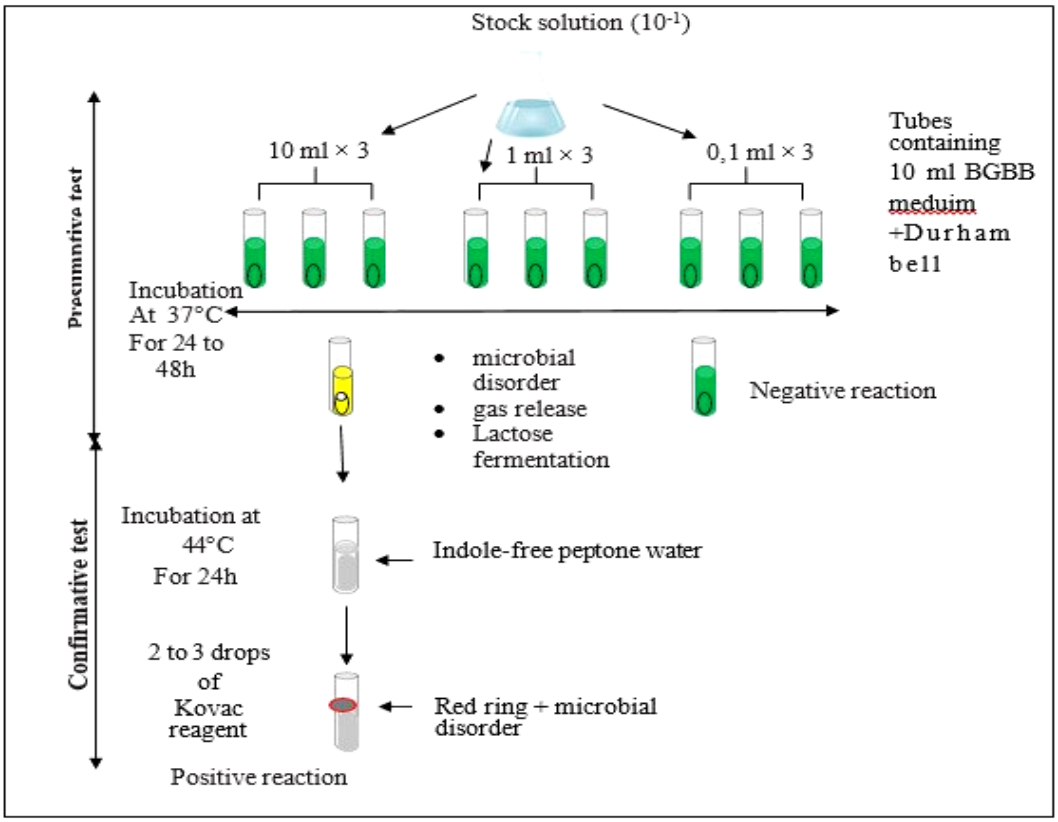


Figure 17: Coliform Research and Enumeration **(personal plug)**.

III.3.4. Research and enumeration of fecal streptococci

Fecal streptococci are enumerated in liquid medium by the NPP method using two culture broths, Rothe medium and Eva Litsky medium. This method involves two consecutive presumptive tests followed by a confirmatory test **(Lebres and Mouffok, 2008)**.

Procedure (streptometrics on liquid medium)

1st step: Presumptive test: Reserved for streptococcus research

From the sample to be analysed:

- 3 times 10 ml in 3 tubes containing 10 ml of ROTHE D/C.
- 3 times 1 ml in 3 tubes containing 10 ml of ROTHE S/C.
- 3 times 0.1 ml in 3 tubes containing 10 ml of ROTHE S/C.

Incubate tubes after mixing at 37°C for 24-48 hours.

Positive tubes are manifested by the presence of a bacterial disorder accompanied by a medium turn in which a *Streptococcus* is presumed and are subjected to the confirmatory test

2nd step: Confirmatory test: reserved for confirmation of fecal streptococci in the positive tubes of the presumptive test **(Chaouche, 2007)**.

After stirring the positive tubes: take a few drops with a Pasteur pipette; transfer them to Eva Litsky medium tubes **(Fig18).**

Mix the medium and inoculum well.

Incubate at 37°C for 24 to 48 hours.

Tubes with :

- A disorder due to bacterial development.
- A purple (whitish) pellet at the bottom of the tube.

Sometimes, the culture agglomerates at the bottom of the tube by fixing the dye and forming a purple pellet **(Rodier et *al*., 2009)**.

The final reading is also done according to the requirements of the NPP table.

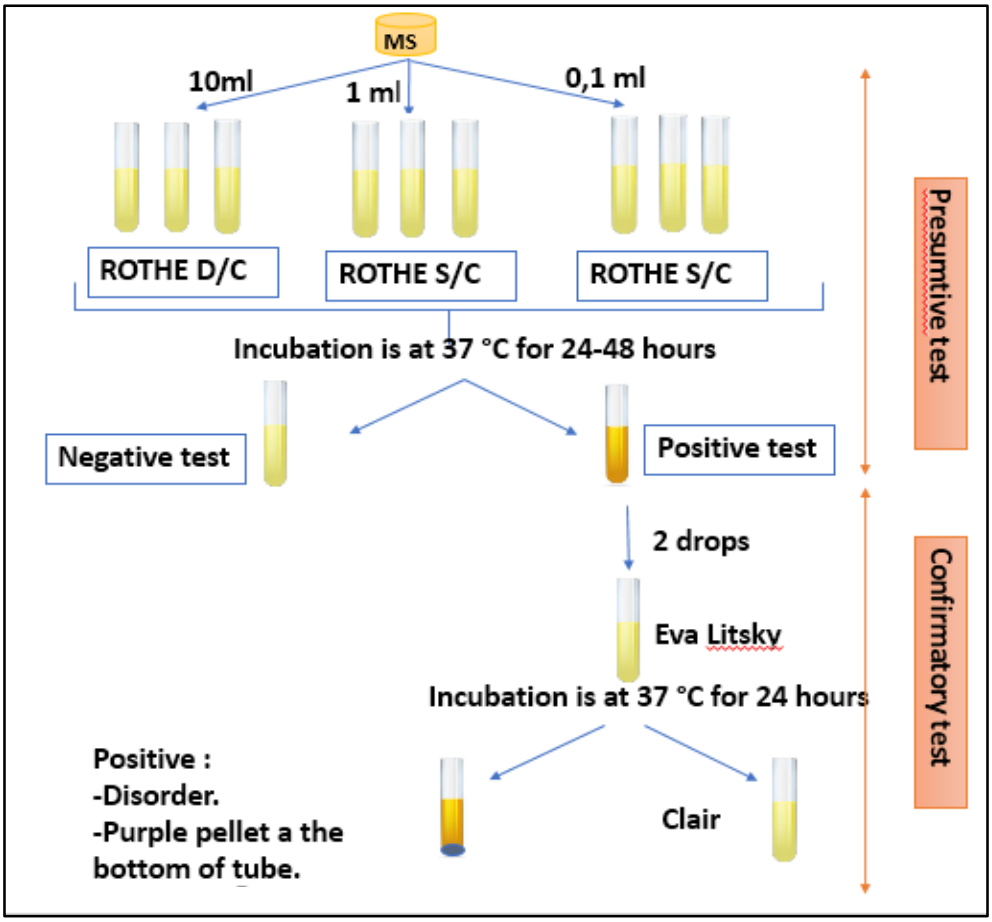


Figure 18: Research and enumeration of fecal streptococci **(personal plug)**.

III.3.5. Search and counting of spores *Clostridium* sulfito-reducing

The anaerobic sulphito-reducing bacteria (ASR) present in gram-positive form, developing in 24 to 48 hours on a Meat Liver (VF) agar giving typical colonies reducing sodium sulfite (Na_2SO_3), which is found in the medium, in sulphide which in the presence of Fe^{+2} which gives FeS (iron sulphide) black. ASR spores are generally indicative of early contamination **(Labres et *al*., 2006)**.

- **Operating mode**

The research and counting of ASR spores is done by the method of incorporation into agar on deep tubes:

- Take approximately 25 ml from the solutions to be analyzed (10^{-1}), in a sterile flask, which will then be heated to 80ºC for 8 minutes, in order to destroy any vegetative forms that may be present.

-After heating, immediately cool the flask under tap water, and then divide the contents of this vial into 4 different sterile tubes at a rate of 5 ml per tube.

- Add about 20 ml of meat liver agar, melted, with 4 drops of iron alum and 0.5 ml of sodium sulphite, then cooled to 45ºC±1ºC.

- The incorporation is done in a tube, and not in a box, in order to limit the contact surface between the medium and the air.

- Mix the medium and inoculum gently, avoiding the formation of air bubbles and the introduction of oxygen.

- Let solidify on a bench for about 30 minutes,

- Add two drops of paraffin oil and incubate at 37ºC for 24 to 48 hours **(Labres and Mouffouk, 2008)**. Consider any black colony surrounded by a black halo as the result of an anaerobic sulphito-reducing spore.

- Express the result in spore count per gram of product to be analyzed. The first reading must absolutely be done at 4 h. and the second reading will be at 24 h. The third and last reading after 48 hours. Count any black colonies 0.5 mm in diameter that have grown in mass and report the total number of colonies in the four product tubes to be analyzed **(Labres et *al*., 2006)**.

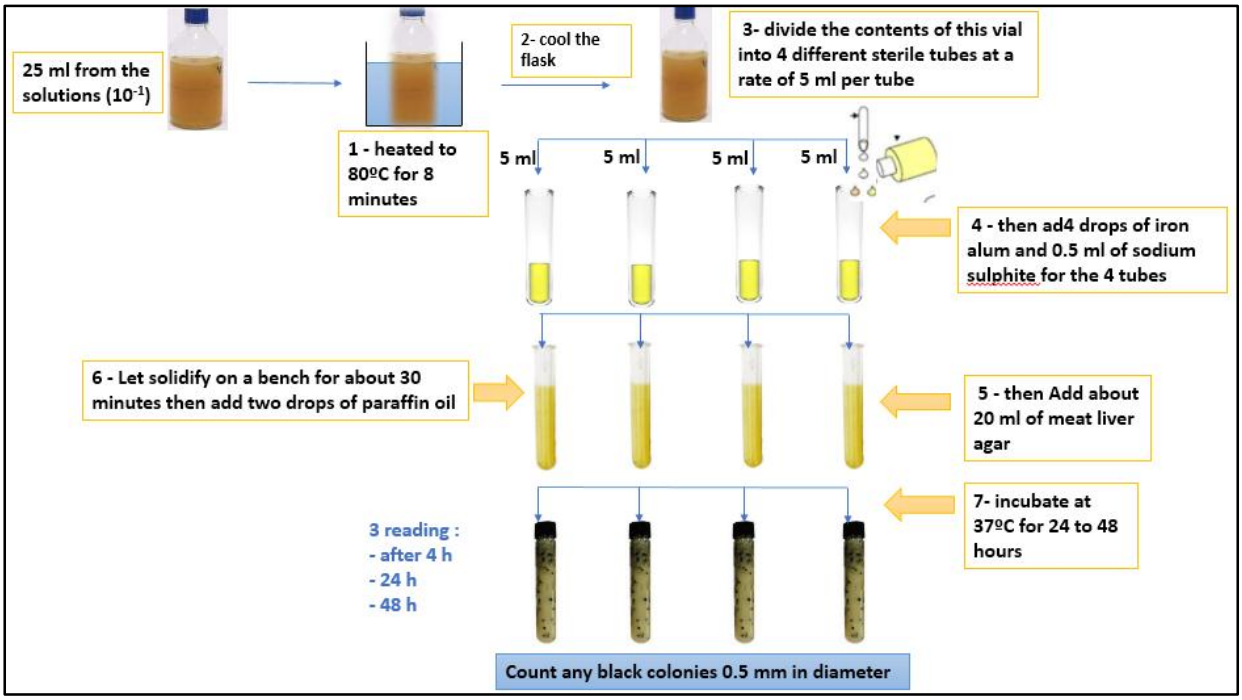


Figure 19: Search and count of *Clostridium* sulfito-reducing spores **(personal plug)**.

III.3.6. *Salmonella* test

Salmonella is a bacterium that contaminates food when hygiene rules are not respected. This is a very important problem in food microbiology. Salmonellosis remains the most common foodborne illness in the world.

- **Operating mode**

Salmonella research was carried out in two stages: enrichment and isolation **(Petransxiene and Lapied, 1981)**.

- **Enrichment:** Before attempting to isolate *Salmonella*,

we promoted their multiplication by using an enrichment medium: the Sodium Selenite medium (SFB). In 10 ml of Selenite cystine broth (SFB) contained in each sterile screw tube, we put 1 ml of subculture (10^{-3}) in a sterile pipette. The broths are then incubated in the oven at 37°C for 24 hours. Divided into tubes and seeded at 1 ml. The seeded broth is incubated at 37°C.

-**Isolation:** is done in an Hektoen medium. Petri dishes are seeded with a strip of platinum, and incubated at 37°C. Results are analyzed after 24 hours from characteristic colonies (Small black colonies).

III.3.7. *Staphylococcus aureus* research and enumeration

Staphylococci are Gram-positive cocci that are widespread in nature (air, water, soil), and often live commensally on the skin and mucous membranes of humans and animals.

-**Isolation:**

From the dilutions (10^{-1},10^{-2}) aseptically applied 2 drops to the surface of Chapman agar, seeded, then incubated at 37°C for 18 to 24 h **(Boudouda et *al*., 2012)**.

III.3.8. Research and enumeration of yeasts and molds

Mold contamination of foodstuffs is currently receiving a great deal of attention due to the mycotoxins these micro-organisms are capable of synthesizing. Molds are widespread in nature (air, soil, etc.); and can easily contaminate foodstuffs during processing. Acidophilic, psychrotrophic yeasts can induce profound alterations in foodstuffs (structure, organoleptic properties, etc.). Most are non-pathogenic **(Baumgart, 1994)**.

- **Operating mode**

Inoculate 1 ml of each chosen dilution (10^{-1},10^{-2}) deep into a well-defined selective Sabouraud Chloramphenicol culture medium, poured into petri dishes. Then prepare further dishes under the same conditions, using decimal dilutions of the test sample or stock suspension. Incubate at 25°C for 5 days.

- **Reading**

Yeasts are reminiscent of bacterial colonies. They are round with regular outlines, opaque, flat on the surface and lenticular in depth; oidiums with a velvety appearance are reminiscent of molds; molds are often pigmented, velvety in appearance and more or less prominent. Calculation of the number of colony-forming units (CFU) of yeasts and/or molds per gram or millilitre of sample, based on the number of colonies obtained in dishes chosen at dilution levels allowing a significant result to be obtained.

III 4. Manufacture of date syrup

The manufacture of date syrup is an ancestral recipe that is based on the use of craft materials to produce a better date syrup.

We have taken the following steps:

-Cleaning and washing of dates.

Figure 20: Washing and soaking of dates **(personal plug)**.

-Put the dates and water in a pot on the fire for 5 to 6 hours until fully cooked and then leave to cool.

Figure 21: Cooking dates on fire **(personal plug).**

Squeeze the dates to extract the juice with the addition of water by using a jar with couscous until brown.

Figure 22: Extraction of date juice using a filter **(personal plug).**

-Strain the extracted juice with gauze and repeat filtration twice.

Figure 23 : filter residue **(personal plug)**

Figure 24: Juice extract(filtrate) **(personal plug)**

-Cook the filtered juice on the heat for 7 to 8 hours to remove the water and obtaining a colored and syrupy liquid.

-Put the syrup in sterilized petri boxes and leave to cool.

Figure 25: Date syrups **(personal plug).**

II.5. Preparing chocolate from date syrups:

The preparation of Rob's chocolate depends on following the following steps:

-Step 1: Priming with date syrup

-We used the date syrup we have already explained **(pages 40 to 42)**.

Step 2: Date syrup chocolate primer

Ingredients:

-Date syrup.

-Cocoa powder.

-Butter.

These ingredients were thoroughly mixed with an electric mixer to obtain a good texture.

-Step 3: Chocolate wrapping

Rob's chocolate is packed in glass boxes.

Finally, it should be kept in the fridge at a temperature of 14-18°C.

Figure 26: Mixing of ingredients **(personal plug)**.

Figure 27: Molding and unmolding chocolate **(personal plug)**.

III.6. Sensory analysis

According to the French standard **NF ISO 5492**, sensory analysis is defined as "An examination that analyzes the organoleptic properties of products through the senses", in which the human being uses these five senses (sight, hearing, smell, taste and touch) to characterize and evaluate products.

To arrive at a fair judgment of the quality of date syrups, the analysis must obey conventional rules.

In order to carry out the tasting test it is necessary to form a number of judges with good experience **(Benard, 1982)**.

The tasting session took place in a serene, fragrance-free environment. Our panel comprised six individuals that represents the middle age group and youth category who abstained from wearing perfume or smoking, ensuring their sensory perceptions were unaltered. The date syrups presented for tasting were maintained in their natural state.

Each tasting procedure followed a systematic approach:

- An ample amount of each sample was introduced into the mouth.
- The sample was allowed to linger on the palate for a duration of 5 seconds.
- Tastings were repeated as necessary to capture the full spectrum of flavor profiles.
- Between each tasting, the mouth was rinsed to neutralize any lingering taste.

The jury was tasked with evaluating several key aspects of the date syrup, including its color, aroma, acidity, bitterness, and texture, in order to provide comprehensive feedback.

Results and discussion

IV.1. Physico-chemical analysis of date syrup

The results of the physicochemical analyzes carried out on the date syrup samples analyzed are illustrated in the table below:

Table 8: The physicochemical characteristics of the four date syrup samples (industrial and traditionl).

Parameters	**Results**			
Date Syrup	**Industrial date syrup**		**Traditional date syrup**	
Samples	**sample 1**	**sample 4**	**sample 2**	**sample 3**
pH	3.68 ± 0.01	4.06 ± 0.01	4.14 ± 0.01	4.54± 0.01
Temperature	16°C	17°C	16.2°C	16.5°C
Titrable acidity (%)	2.4%	2.76%	3%	0.84%
Water content %	17%	21%	18%	30%
Brix	78.7± 0	74.4 ± 0	78.1± 0	67.5 ± 0
Ash content %	4 % ± 0	2.9% ± 0	3.25% ± 0	5.5 % ± 0
Sugar content%	70.46 %		69.9%	

1.PH

The pH is a quality index determining the preservation capacity of food. It is therefore important to measure the pH, in order to know the stability of the food in relation to microbial proliferation.

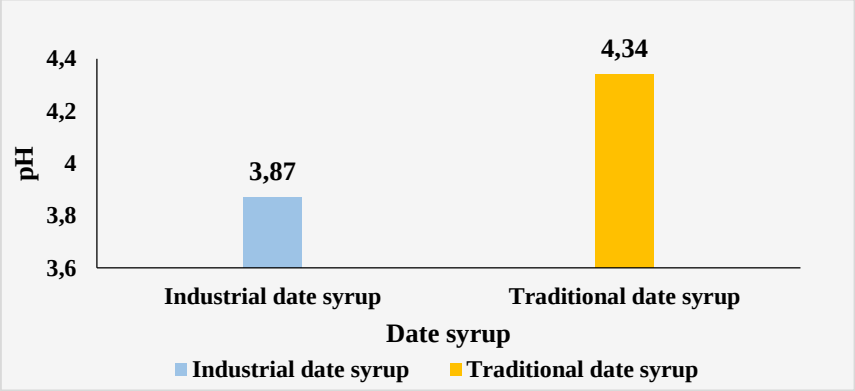


Figure 28: pH values of two different date syrups (industrial and traditional).

Our physico-chemical analysis results showed that the average pH of industrial syrups (3.87) is different to that of traditional syrups (4.34) **(Table 8)**, the values recorded vary between 3.68 and 4.54 (**Figure28)**.

Our values obtained from date syrup are slightly lower than those obtained by **Mimouni and Siboukeur (2011)** which is of the order of 5.09.

Our values are also similar to those reported by **Haddia et *al*., (2014)** in a study conducted on two types of traditional (pH 4.10) and industrialized (pH 4.63) date syrup. This difference could be due to the storage time of the dates used in the transformation as the pH decreases with the increase in storage time at T °C ambient.

2.Titratable acidity

Titratable acidity is a quantitative index that allows to judge the freshness of our date syrup; it is also closely related to organic product acids under the action of microorganisms on reducing sugars that are present with abundance in our product.

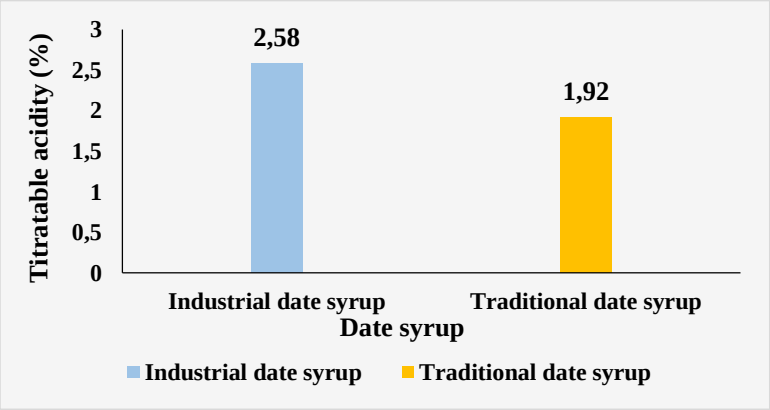


Figure 29: Titratable acidity values of the two date syrups (Industrial and traditional).

Our results showed that, the titratable acidity of the syrups studied varies between 0.84% and 3% fresh matter, the sample (3) of the traditional date syrup represents the lowest acid rate estimated at 0.84%. **(Figure 29)**.

This value of titratable acidity of whole date syrup is different to those reported by **Chiban (2007)**, who found for the varieties values of date syrups obtained from 0.24%, 0.21% and 0.19% respectively.

Organic acids are usually intermediates of metabolic processes. They have an impact on the growth of micro-organisms and on the preservation quality of products (**Al-Farsi et *al*., 2005).**

3.Water content

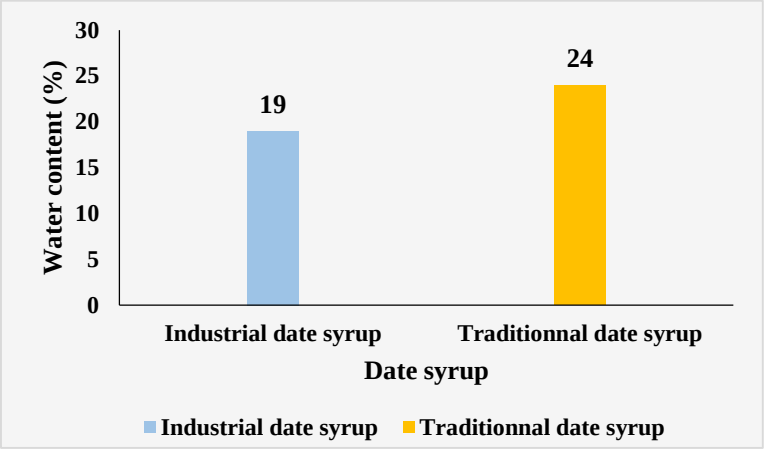


Figure 30: Water content of different date syrup samples.

Our analysis reveals that traditional date syrups exhibit the highest moisture content at 24%, whereas industrial variants display the lowest at 19% **(Figure 30)**.

This finding aligns with previous research by **Manickavasagan et *al.*, (2012)**, which demonstrated moisture variations ranging from 7% to 38% in dates at the Tamr stage.

The disparities in water content between the two syrup types likely stem from divergent processing methods, including the duration and temperature of evaporation (syrup concentration), as well as procedural variations and equipment utilization.

Moisture content significantly influences microbial growth in food products. Variations in moisture levels may be attributed to extraction techniques, environmental factors, storage conditions, and the specific date cultivars utilized **(Saidani, 2017)**.

According to **Mimouni (2015)**, condensation also plays a crucial role in regulating water content. This process aims to reduce the water activity of syrups, thereby facilitating their preservation. However, it's important to note that moisture content serves as a primary factor in promoting microbial proliferation. Certain molds and yeasts can thrive in sweet environments with intermediate humidity levels around 25%.

4.Brix° soluble solids content

The Brix degree of date syrup obtained is 76.55° Bx for the industrial sample and 72.8° Bx for the traditional sample **(Figure31)**.

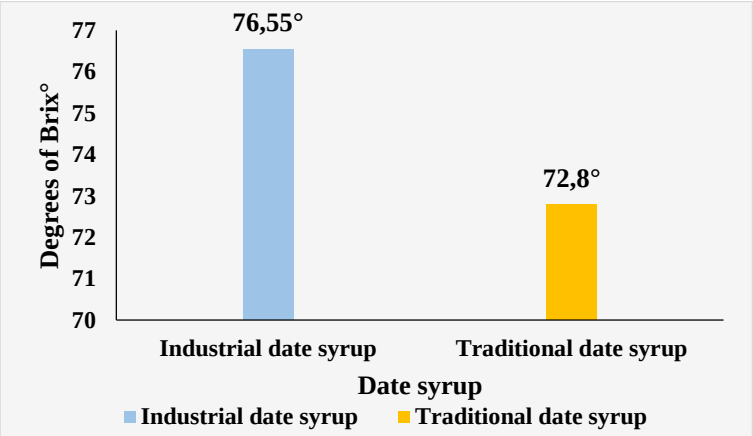


Figure 31: Brix degree of the two different syrups.

Overall, our findings closely resemble those obtained by **Harrak and Boujnah (2012)**, indicating a consistency with the figures reported by **Mimouni (2015)**, which fall within the range of 72.33% to 73.20%. However, our results surpass the fructose Total Soluble Solids (TSS) reported by **Anonyme (2013)**, which stands at 40.01%.

This suggests that the concentration of syrups correlates with the content of soluble solids, a relationship contingent upon the extraction technique employed.

5.Ash content

The total ash content of a foodstuff allows for the estimation of the mineral content of that foodstuff.

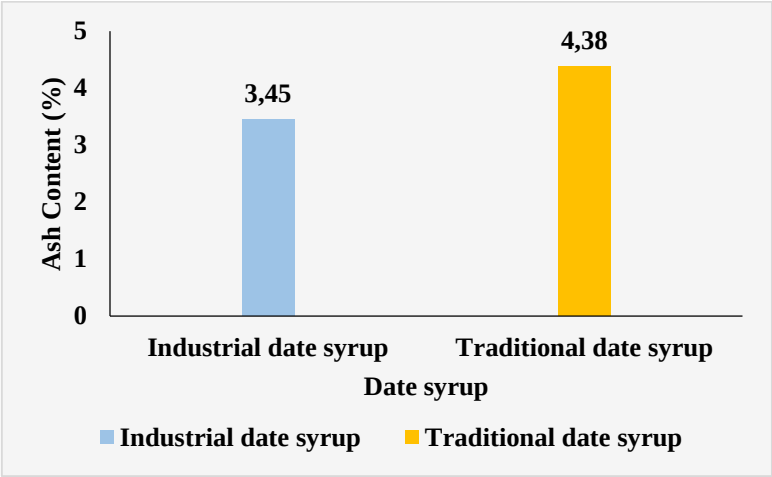


Figure 32: Ash content of the two date syrups.

Our results obtained, namely 3.45% (Industrial) and 4.38% (Traditional), are consistent with those reported by **Mimouni and Siboukeur (2011)**, who observed an ash content ranging from 2.1% to 4% in date syrups.

It should be noted that mineral content may vary depending on the techniques employed and the extraction conditions during the cooking of the dates **(Belguedj et *al.*, 2015)**.

6.Sugar content

Dates are composed primarily of sugars, with sucrose, glucose, and fructose being the most prevalent. These sugars are responsable for the sweetness of dates.

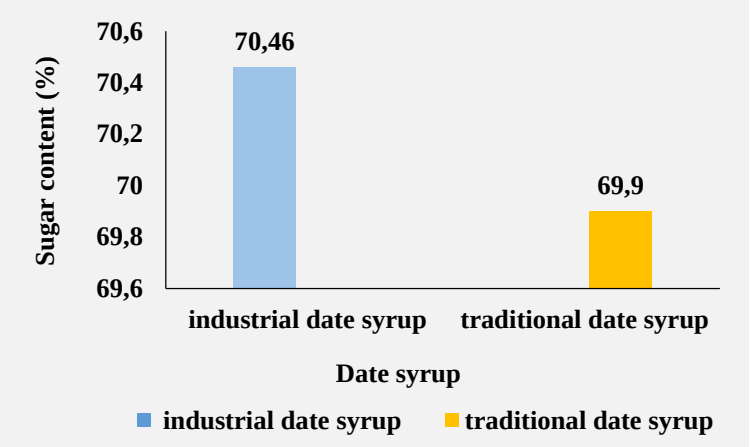


Figure 33: Sugar content of the two date syrups.

Our findings revealed a sugar content of 70.46% for the industrial sample and 69.9% for the traditional sample. These values align closely with those documented by **Boussaïd et *al.*, (2020)**, who observed sugar contents of 71.11% for Rob Ghars and 69.7% for Rob Mech-degla.

This consistency suggests that the sugar content of date syrups tends to be elevated, reflecting the substantial presence of sugars inherent in dates themselves.

IV.2. Microbiological analysis

The table (9) displays the outcomes following the microbiological assessment of five date syrup samples: two industrially produced from the wilaya of Biskra, two traditional samples obtained from the wilayas of Biskra and Djelfa, and a self-made chocolate sample utilizing date syrup. The objective was to detect and enumerate microorganisms associated with foodborne illnesses, thereby evaluating microbiological quality to ensure consumer safety.

Conformity analysis was conducted in accordance with the standards outlined in the Official Journal of the Algerian Republic **(J.O.R.A No. 39 of 02 July; 2017)** concerning food products. Adherence to these safety criteria is imperative to guarantee consumer protection.

Our findings indicate a complete absence of pathogenic bacteria such as *Staphylococcus aureus*, *Salmonella*, total and fecal coliforms, *Clostridium* sulfito-reducers and fecal streptococci across all syrup samples analyzed. This absence underscores the compliance of the syrup samples with the established safety standards.

Table 9: The microbiological characteristics of the four date syrup samples (industrial and traditional) and organic chocolate (sample 5).

Samples / **Germs research. (UFC/ml)**	**Sample 1**	**Sample 2**	**Sample 3**	**Sample 4**	**Sample 5**	**Norme**	**Reference**
TMAF	<30 CFU/ml	<30 CFU/ml	3 .10³ CFU/ml	<30 CFU/ml	<30 CFU/ml	_____	**(NM ISO 4833-2008)**
TC and FC	Abs	Abs	Abs	Abs	Abs		**J.O.R.A. No. 39 of July 2,2017**
fecal streptococci	Abs	Abs	Abs	Abs	Abs	_____	
Anaerobic sulfite-reducing bacteria (ASR)	Abs	Abs	Abs	Abs	Abs	_____	
Salmonella	Abs	Abs	Abs	Abs	Abs		**J.O.R.A. No. 39 of July 2,2017**

Staphylococcus aureus	Abs	Abs	Abs	Abs	Abs	_____	
Yeasts and molds	Abs	Abs	Abs	Abs	Abs	$<10^3$ UFC/ml	**J.O.R.A. No. 39 of July 2,2017**

- **Total mesophilic aerobic microflora (TMAF) count result**

Detection and enumeration of spoilage microorganisms, particularly mesophilic aerobic microflora, is a pivotal assessment in food safety analysis. A high number of mesophilic flora indicates a significant microbial activity, which may accelerate the spoilage process. It's worth noting that while a robust mesophilic flora suggests an advanced stage of microbial alteration, there isn't always a direct correlation between the quantitative significance of this flora and the time it takes for organoleptic changes to become perceptible **(Bourgois and Leveau, 2011)**.

The microbiological analysis revealed an absence of total mesophilic aerobic flora in samples numbered (1, 2, 4, and 5). However, sample number 3 exhibited a microbial load of 3 x 10^3 CFU/ml.

Comparing our findings with European standards for concentrated products, which stipulate a threshold of 3.10^3 CFU/ml for total mesophilic aerobic flora (TMAF) germs, it is evident that our values fall within an acceptable range **(Ndiaye, 2015)**.

Moreover, it is also noted that the number of TMAF germs observed does not exceed the values indicated by international standards **(NM ISO 4833-2008)**, this reaffirms the satisfactory quality of both types of traditional and industrialized syrup variants.

Therefore, the presence of germs in traditional sample number 3 is probably due to hygienic conditions, and the method of making date syrup.

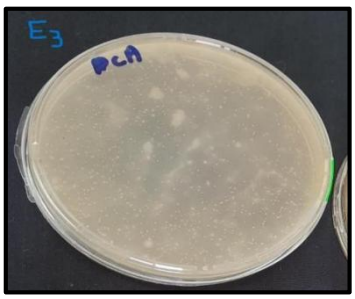


Figure 34: Represents the TMAF in PCA medium for sample (3) **(personal plug)**.

- **Enumeration of fecal and total coliforms:**

The coliform group was not detected in any of the date syrup samples. This absence can be attributed to the steam extraction, and direct heat methods utilized during the syrup production process, as well as the higher sugar ratio present. Furthermore, the strict hygienic practices followed during the processing date syrup probably helped to eliminate coliforms **(Zuhair et *al*., 2022)**.

Additionally, this microbiological safety can also be attributed to the quality of the raw materials (presence of bioactive substances such as polyphenols).

Figure 35: Represents the absence of FC in BGBB medium **(personal plug)**.

- **The enumeration of pathogenic germs yielded the following results: fecal streptococci, *Clostridium* sulphite-reducers (CSR), *Staphylococcus aureus* and *Salmonella*.**

The absence of the pathogenic germs that were being sought was identified. The enumeration of pathogenic germs in the two types of date syrup analyzed yielded the following results: fecal streptococci, *Clostridium* sulphite-reducers, *Staphylococcus aureus*, and *Salmonella*. These results are comparable to those reported by **(Haddia et *al*., 2014)**, who studied the quality of date syrup (Tahlaoute) in Morocco.

These findings underscore the compliance of both types of date syrup with Algerian microbiological standards outlined in **(J.O.R.A N° 39 of 02 July, 2017)**. This supports the assertion that the samples exhibited satisfactory microbiological quality, deemed to be good.

The observed results can be attributed to adherence to stringent hygiene practices throughout the manufacturing and distribution process, as well as the application of heat treatment during syrup preparation. They may also be linked to the microbiological quality of the raw material used and the inhibiting effect of the antimicrobial compounds contained in the dates.

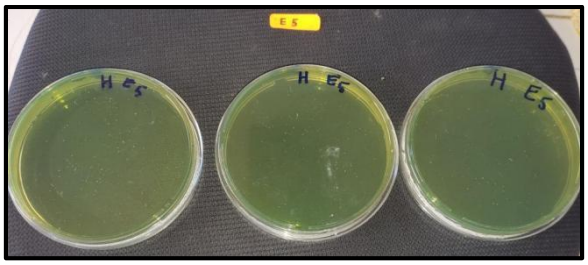


Figure 36: Represents the absence of *Salmonella* in Hektoen medium **(personal plug)**.

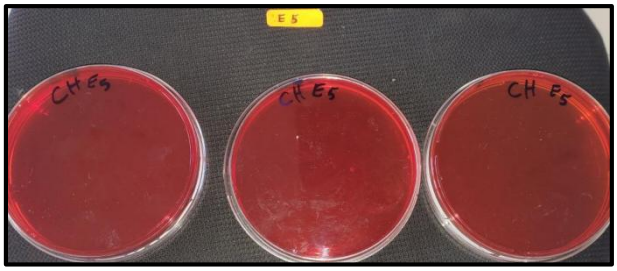


Figure 37: Represents the absence of *Staphylococcus aureus* in chapman medium **(personal plug)**.

Figure 38: Represents the absence of *Streptococcus* in ROTHE medium **(personal plug).**

- **The results of the yeasts and molds**

The microbiological analysis further revealed the absence of yeasts and molds in the samples. These results align with the critical thresholds specified by both international standards **(NF ISO 4833-2008)**, and Algerian regulations (10^{-3} UFC/g) outlined in **(J.O.R.A N° 39 du 02 Juillet, 2017)**.

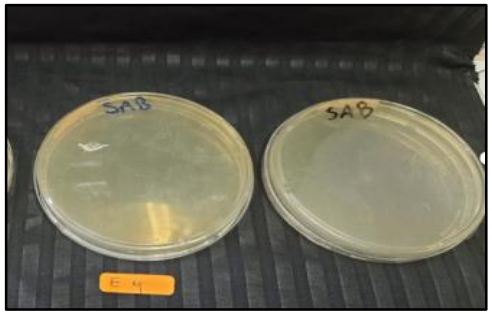


Figure 39: Represents the absence of yeasts and molds in Sabouraud Chloramphenicol culture medium **(personal plug)**.

It should be noted that the acid pH is unfavorable to the proliferation of bacteria but favorable to the proliferation of yeasts and molds, which explains well the absence of total and fecal coliforms as well as pathogenic germs: *Clostridium* sulfito-reducers, *Staphylococcus aureus* and *Salmonella* in both types of date syrup analyzed and the presence of fungal flora in almost all samples of traditional syrups.

IV.3. Results of the sensory analysis

After the tasting process of the artisanal date syrup by the jury that represents the middle age group and youth category, here are the results:

Table 10: Tasting test of "**Artisanal date syrup**".

Batch Attributes	Texture	Smell	Color	Taste	Appreciated global
1	Light	Acceptable	Light brown	Pleasant	Excellent
2	Light	Acceptable	Light brown	Pleasant	Acceptable
3	Light	Acceptable	Light brown	Pleasant	Acceptable
4	Light	Pleasant	Light brown	Pleasant	Excellent
5	Light	Acceptable	Light brown	Pleasant	Acceptable
6	Light	Pleasant	Light brown	Pleasant	Excellent

The sensory analysis revealed that the artisanal date syrup exhibited better taste, color, and texture compared to its industrial counterpart.

Participants in the sensory evaluation expressed a preference for the natural and rich flavor profile of the artisanal date syrup.

And for the sensory analysis of organic chocolate, results showed:

Table 11: Tasting of date syrup-based chocolate by the juries.

Evaluated Criteria :	Nb of points	Jury 1	Jury 2	Jury 3	Jury 4	Jury 5	Jury 6
1- Taste: - Taste of burnt or various tastes not corresponding to the expected product	0						

- Normal chocolate mousse taste with noticeable aftertaste	1 -2	6/8	7/8	7/8	7/8	6/8	5/8
- Normal chocolate mousse taste without aftertaste.	3 -4 -5						
- Harmonious taste of chocolate mousse.	6 -7						
- Excellent, intense and very pleasant taste	8						
2- smell: - Burnt	0	4/5	5/5	4/5	4/5	3/5	4/5
- Good corresponding to the product	1-2- 3						
- excellent smell, intense and very pleasant.	4-5						
3- Color: - Color not corresponding to the expected product	0	3/5	4/5	4/5	3/5	2/5	3/5
- Color partially corresponding to the expected product, lighter or darker	1 – 2						
- Color corresponding to the product	3 – 4						
- Characteristic and flawless colour	5						
4- texture: - Product too liquid, presence of piece, not homogeneous	0	2/2	2/2	2/2	2/2	2/2	2/2
- Product not sufficiently abundant	1						
- light and homogeneous product	2						
Total of 20 points T=	**20**	**15/20**	**18/20**	**17/20**	**16/20**	**13/20**	**14/20**

The organic chocolate that was made with date syrup was recognized for its appealing taste and texture. The tasters were impressed, particularly due to the complementary color and smell of the product. This contributed to the positive reception it received among the tasters.

The sensory analysis has shown that incorporating date syrup into chocolate production enhances both taste and flavor, offering a distinct sweetness profile compared to traditional chocolates. This natural sweetener, used without additional sugar, creates unique textural experiences while aligning perfectly with health-conscious consumers seeking organic alternatives.

Conclusion

Conclusion

In Algeria, dates, and their by-products hold significant importance role in both the agricultural sector, and for consumers, owing to their diversity and high nutritional value.

Our study encompassed two main phases: initially, we crafted natural date syrup using the traditional method and then utilized it to create 100% natural organic chocolate. In the subsequent phase, we focused on evaluating the quality of date syrup (Rob) produced through both traditional artisanal and industrial methods. We subjected the artisanal date syrup-derived chocolate to rigorous physico-chemical and microbiological analyses.

From the analyses carried out, we can see that date syrups can cover energy requirements in a significant way, given their high sugar content. Moreover, this syrup can serve as a viable sugar substituter, and can be added to various industrial products such as chocolate, helping to lower blood sugar levels. Microbiological results indicated that our samples (date syrups and manufactured chocolate), generally met established standards.

Furthermore, sensory analysis revealed that the organoleptic properties of the artisanal date syrup surpassed those of the industrial variant. Additionally, upon tasting the chocolate we produced, we concluded that this chocolate is a healthier and more natural alternative, as it is made from date syrup, which is rich in fiber and antioxidants, and contains no added sugar, better than chocolate on the market.

In conclusion, our study highlights a dual benefit: the elaboration of a 100 % natural date syrup by the traditional method using dates of low interest, and low price for the Algerian human consumption, and their valorization in the manufacture of 100 % organic chocolate as a substitute for refined sugar.

In order to complete this study, it would be interesting to:

✓ Explore the utilization of date pits from syrup production for extracting oils, and crafting cosmetics.

- ✓ Investigate the possibility of producing cakes or other food products using the date paste left over after syrup filtration.
- ✓ To promote the development of a 100 % natural food industry using the versatility and nutritional benefits of date products.

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Annex

People's Democratic Republic of Algeria

Ministry of Higher Education and Scientific Research

University 8 May 1945 of Guelma

Faculty of Natural and Life Sciences, Earth and the Universe

Department of Ecology and Environmental Engineering

Specialty: Applied microbiology

Project title:

Valorization of date syrup for the manufacture of Bio-chocolate and organic sweets

Academic year: 2023-2024

Information card:

About the Working Group Leadership Team

Coaching Team :

Coaching Team	
Supervisor 01 Dr. HADDIDI Imane	**Speciality** Biology
Supervise 02 Dr. MALEK Insaf	**Speciality** Biology

Project team :

Project team	**Speciality**
Student 01 BENKREIF Lamis	Applied microbiology
Student 02 BENNOURI Dourssaf	Applied microbiology
Student 03 LOUNISSA Amani	Applied microbiology

First axis: Presentation of the project

1. Project idea (proposed solution).

Our focus lies within the natural food industry, particularly specializing in the production of natural chocolate infused with date syrup.

The genesis of our project sprouted from a visit to a nutritionist, where we encountered numerous patients grappling with health issues such as diabetes, obesity, and anemia. It became evident that finding healthy alternatives to medication, with their multitude of side effects, exorbitant costs, and limited availability, posed a significant challenge. Hence, we embarked on a quest for accessible and sustainable solutions.

Our venture into chocolate production utilizing date syrup stands as a pivotal project, given its scarce presence in Algeria, and the strong demand from consumers seeking natural dietary options. This is not a recent project; our ongoing project signifies a commitment to harnessing the potential of date syrup. Our initial focus on organic chocolate and confectioneries serves as the cornerstone of our broader vision—a culinary venture dedicated to crafting natural products and catering to discerning consumers.

In order to minimize the consumption of non-natural products used for the treatment of diseases and to favor the use of natural products while enhancing local Algerian products. To this end, we are poised to introduce a new brand of natural products, prominently featuring date syrup as a primary ingredient.

We were inspired to harness the natural bounty of date syrup, a treasure trove of antioxidants renowned for its ability to combat free radicals and bolster the body's defenses. Laden with essential nutrients like iron, potassium, and magnesium, it presents a wholesome alternative to refined sugar in our culinary concoctions.

The target consumer base for our products encompasses women, and men of all age groups, with a special emphasis on individuals pursuing dietary regimens and those grappling with health challenges such as diabetes, anemia, and obesity.

Reaching the attention of our target audience necessitates a multi-faceted approach. We employ strategic advertising campaigns across social media platforms, leveraging insights into market demands and preferences. Additionally, we seize opportunities to engage directly with consumers through promotional initiatives in local markets. Central to our strategy is the establishment of a state-of-the-art production facility, equipped with cutting-edge technologies, to ensure the highest standards of quality and efficiency.

We operate through three primary workshops:

The first workshop focuses on the meticulous preparation of raw materials, specifically the extraction of date syrup a crucial ingredient in our culinary creations.

In the second workshop, skilled artisans embark on the craft of chocolate making, transforming premium ingredients into delectable treats that tantalize the taste buds.

Finally, our sub-workshops specialize in the intricate processes of packaging and storage, ensuring that our products are meticulously preserved until they embark on their journey to delighted consumers.

2. **Proposed values:**

Our project will propose several values as follows:

- **Healthier Alternative:** Date syrup is a natural sweetener made from dates, which are rich in vitamins, minerals, and fiber. Compared to processed sugars used in traditional chocolate, date syrup offers a healthier option with a lower glycemic index.
- **Natural product:** Date syrup Chocolate contains no preservatives or artificial ingredients.
- **Unique taste:** Date syrup give a distinctive, and sweet taste to chocolate, making it a natural place without the need to add excess sugar.
- **Offer a variety of flavors:** Add natural ingredients such as nuts and dried fruits.
- **Nutritional Value:** Date molasses contain many useful nutrients such as fiber, vitamins and minerals, making date syrup chocolate a relatively healthy option compared to traditional chocolate.
- **Vegan and Dairy-Free Option:** By using date syrup and plant-based fats like coconut oil or cocoa butter, you can make chocolate that is suitable for vegans and those with dairy allergies or intolerances.

- **Antioxidant Properties:** Cocoa powder, the main ingredient in chocolate, is rich in antioxidants called flavonoid. Combining cocoa powder with date syrup may enhance the antioxidant properties of the chocolate, providing potential health benefits such as improved heart health and reduced inflammation.
- **Health Popularity:** With the trend towards healthy eating, date syrup chocolate is an attractive health alternative for people looking for healthy sweet options.
- **Stimulation of the date industry:** By using date syrup in the chocolate industry, the demand for dates can be increased, thus stimulating the date industry in the producing countries and boosting the local economy.
- **Sustainable product:** Date syrup is made from dates, a renewable crop.
- **Attractive packaging:** Using eco-friendly packaging that reflects the quality of the product.
- **Easy to store and use:** Date syrup chocolate can be used in many recipes, and can be stored for a long time.
- These products are available at affordable prices, affording customers the opportunity to acquire them.

Overall, making chocolate from date syrup can be a nutritious and delicious alternative to store-bought chocolates, offering a guilt-free indulgence packed with flavor and health benefits.

3. Task Team:

The project team consists of the following members:

- Benkreif Lamis:

Graduate student, Master 2 in applied microbiology at the Faculty of Natural and Life Sciences, Earth and the Universe.

- Computer skills: (Word, Excel, Power point)
- She has skills in the field of chocolate making

She has led training courses in:

- E-commerce with Arvea company of cosmetics and natural product
- Marketing and sponsoring
- Herbal preparation
- Communication
- Business Model Canvas (BMC)
- Prototyping
- Design Thinking (DT)

The role of student 01 is team management, communication and project management.

- Dourssaf Bennouri:

Graduate student, Master 2 in applied microbiology at Faculty of Natural and Life Sciences, Earth and the Universe

- Mastery of computer tools: (Word, Excel, Power point)
- She has skills in the field of natural foods and natural cosmetics.

She has led training courses in:

- E-markeing and content creation
- Customer Service- Managing key Customers
- Therapeutic nutrition
- Design Thinking (DT)
- Business Model Canvas (BMC)
- Prototyping

The role of student 02 is market research and marketing

- Lounissa Amani:

Graduate student, Master 2 in applied microbiology at Faculty of Natural and Life Sciences, Earth and the Universe

Computer skills: (Word, Excel, Power point)

- She has skills in the field of chocolate making

She has led training courses in:

- Business Model Canvas (BMC)
- Prototyping
- Design Thinking (DT)
- Photography

The role of student 03 is to develop design skills.

4. Objectifs de Projet :

Our aim is to become the leading company in Algeria for chocolate manufacturing with date syrup, and we anticipate a substantial share of the Algerian market, which is estimated at 30 percent

- **Short-Term Objectives**
  - ✓ **Consumer Awareness:**
    - Educate consumers about the nutritional advantages of date syrup as a natural sweetener alternative, emphasizing its superiority over refined sugars.
  - ✓ **Nutritional Labeling:**
  - ✓ Ensure clear and informative nutritional labeling to elucidate the health benefits of our products, empowering consumers to make informed choices.
  - ✓ **Product Development**
    - Finalize the recipe and formulation for date syrup chocolate.
    - Ensure product quality and consistency through testing and refinement.

- ✓ **Market Entry**
  - Launch the product in selected markets or through pilot programs.
  - Establish partnerships with retailers and distributors.
  - Initiate marketing and promotional campaigns to create brand awareness.
- ✓ **Regulatory Compliance**
  - Obtain necessary certifications and approvals for health and safety standards.
  - Ensure labeling and packaging meet regulatory requirements.
- ✓ **Customer Feedback**
  - Gather and analyze initial customer feedback to identify areas for improvement.
  - Adjust product and marketing strategies based on consumer responses.

- **Long-Term Objectives**
  - ✓ **Health Impact Studies**
    - Conduct comprehensive, long-term studies elucidating the health benefits of date syrup chocolate, delving into factors such as glycemic index, antioxidant levels, and overall wellness.
  - ✓ **Market Expansion**
    - Expand distribution to national and international markets.
    - Diversify product line with variations in flavors or additional health benefits.
  - ✓ **Brand Recognition**
    - Establish the date syrup chocolate as a recognized and trusted brand.

- Increase brand loyalty through sustained marketing efforts and customer engagement.

✓ **Sustainable Practices**

- Implement environmentally friendly production and packaging methods.
- Promote sustainable sourcing of ingredients, particularly date syrup.

✓ **Financial Goals**

- Achieve profitability and ensure long-term financial sustainability.
- Secure investments for scaling up production and expanding operations.

✓ **Innovation and Development**

- Invest in research and development for continuous product innovation.
- Stay ahead of market trends and consumer preferences with new product offerings.

By focusing on these objectives, the date syrup chocolate project can establish a solid foundation in the market, build a loyal customer base, and ensure sustainable growth and profitability over time.

5. Project Delivery Schedule:

	number of months / Steps	1	2	3	4	5	6	7	8
1	Preliminary studies: choice of the location of the production unit, preparation of the necessary documents	■							
02	Equipment control		■						
03	Rental of a production site (factory)		■						
04	Installation of equipment		■	■					
05	Purchase of raw materials			■					
06	Cooking dates after washing and pitting them.				■				
07	Extraction of syrup date					■			
08	the manufacture of the chocolate						■		
09	Fill the chocolate in appropriate cartons and pack.						■	■	
10	packing, empacking chocolate							■	
11	Production of the prototype							■	
12	store the products until they are transferred to delivery companies or direct sales outlets								■

Second axis : Innovative aspects.

1. The nature of innovations

The nature of the innovations adopted in the project is part of:

- **Radical innovations:**

  Our commitment to innovation is reflected in our focus on enhancing local date varieties that have been overlooked in Algerian markets, particularly through the utilization of date syrup in our natural products like dark chocolate and coating chocolate. These offerings are crafted sustainably, and with environmental consciousness, embodying both health benefits and therapeutic qualities. In stark contrast to products laden with chemicals, ours are designed with creativity, ensuring distinctive design and presentation to delight our customers.

- **The advanced technological innovations:**

  revolutionize our products, from improving processing and production processes, to enhancing seamless storage and expansion. We also make it easier for you to market online and social media, to provide you with a comprehensive experience that meets your needs efficiently.

- **Market innovations:**

  we harness market innovations to serve our project, and help our customers understand its benefits and products, and how it contributes to supporting society and the environment. We also employ the power of digital marketing to attract new customers

and enhance the spread of our project in local and international markets.

❖ **Increasing innovations**:

Our enterprise is enriched by its increasing innovations, from developing new products that meet changing market needs, to expanding the export scope to new international markets. We also enhance the efficiency of our operations by optimizing manufacturing processes and plant development, to ensure exceptional product quality and promote sustainable production.

2. Innovative aspects

❖ **Product innovation**

-**Developing new types of date syrup:** such as date syrup with different flavors (such as vanilla), or date syrup with additional ingredients (such as nuts, seeds, or dried fruits).

-Create innovative products using date syrup: such as chocolate bars, chocolate coatings, or sweets.

-Innovative and attractive packaging design: attracts consumer's attention, and highlights the benefits of the product with the lowest price of packaging.

❖ **Innovation in marketing**

-Targeting new market segments: such as anemia patients, diabetics, celiac disease patients, athletes, vegetarians, or people with gluten sensitivity.

-Create strong digital marketing campaigns: focusing on the health benefits of date syrup and nutritional value.

-Collaborate with social media influencers: to promote the product to a wider audience

-Brand innovations: such as creating a strong and unique brand identity for the product using only local dates, or using engaging storytelling to connect with consumers.

❖ **Innovations in distribution**

-Innovations in distribution channels: such as selling the product through new channels such as e-commerce, farmers markets, or health food stores.

-Supply chain innovations: such as using new technologies to improve supply chain efficiency and reduce costs.

-Innovations in delivery: such as home delivery to provide fast and efficient delivery services to consumers

-Exporting to new markets: where date molasses may not be readily available

❖ **Innovation in production**

-Innovations in quality management: such as implementing strict systems to ensure product quality and safety.

-Innovations in sustainability management: such as reducing the environmental impact of project operations

-Innovation in production and recycling of dates.

-Ensure high quality of ingredients

-Obtaining certifications such as organic or fair trade: to enhance consumer confidence

Third axis: Strategic Market Analysis

1. **Market sector overview:**

Potential market:

-For anyone looking for 100 % natural food products to help them in their daily lives;

-For people looking for food products free of preservatives, colorants, and chemicals, which improve nutrition and treat many illnesses instead of chemical drugs;

-For people suffering from obesity, anemia, diabetes, celiac disease, etc...;

-For all commercial stores selling natural foods and "Bio" products, both inside and outside the state;

-For industrial companies specializing in manufacturing medicines, herbal remedies, and nutritional supplements.

The target market:

We strive to provide natural products such as date syrup and chocolate made from this 100% pure syrup, to people suffering from many health problems such as low iron levels in the blood, indigestion, and to avoid consuming harmful white sugar...

Our product is considered to have the high nutritional value that consumers need, due to the absence of this type of product on the market.

2. Measuring the intensity of competition:

2.1. Crucial competitors in the Algerian market:

Companies that produce date syrup such as:" Sarra"and "لؤلؤة الزيبان", for chocolate, there are no companies that make chocolate from date syrup. So there are no direct competitors, which is why we chose this project. However, we will take into account competitors following the same idea in neighboring and nearby states.

2.2. Indirect competitors :

For indirect competitors are producers of raw materials, and all products made from dates are considered as competitors for your company.

2.2.1. Strengths :

-Longstanding presence in the Algerian market;

-Brand strength;

-Providing high-quality natural, and organic products;

-Focus on the nutritional needs of customers in the Algerian market;

-Modern technical capabilities to manufacture products, and improve quality;

-Customer/additional services include express shipping/forwarding, and free delivery, and effective product marketing and advertising in a civilized/advanced manner.

2.1.1. Weak points

-Their dependence on modified products containing chemicals;

-The target market segment may be small, requiring even greater marketing efforts to attract customers;

-Competitors may lower prices or offer more services to increase appeal;

- Competition from many large and small suppliers in the market;

-Marketing difficulties in certain geographical areas of Algeria.

3. Strategic analysis/Marketing strategies

3.1. SWOT analysis

The SWOT analysis is based on the distinction between what is internal to the company and what is external, and through it we have extracted the diagnosis in the following diagram:

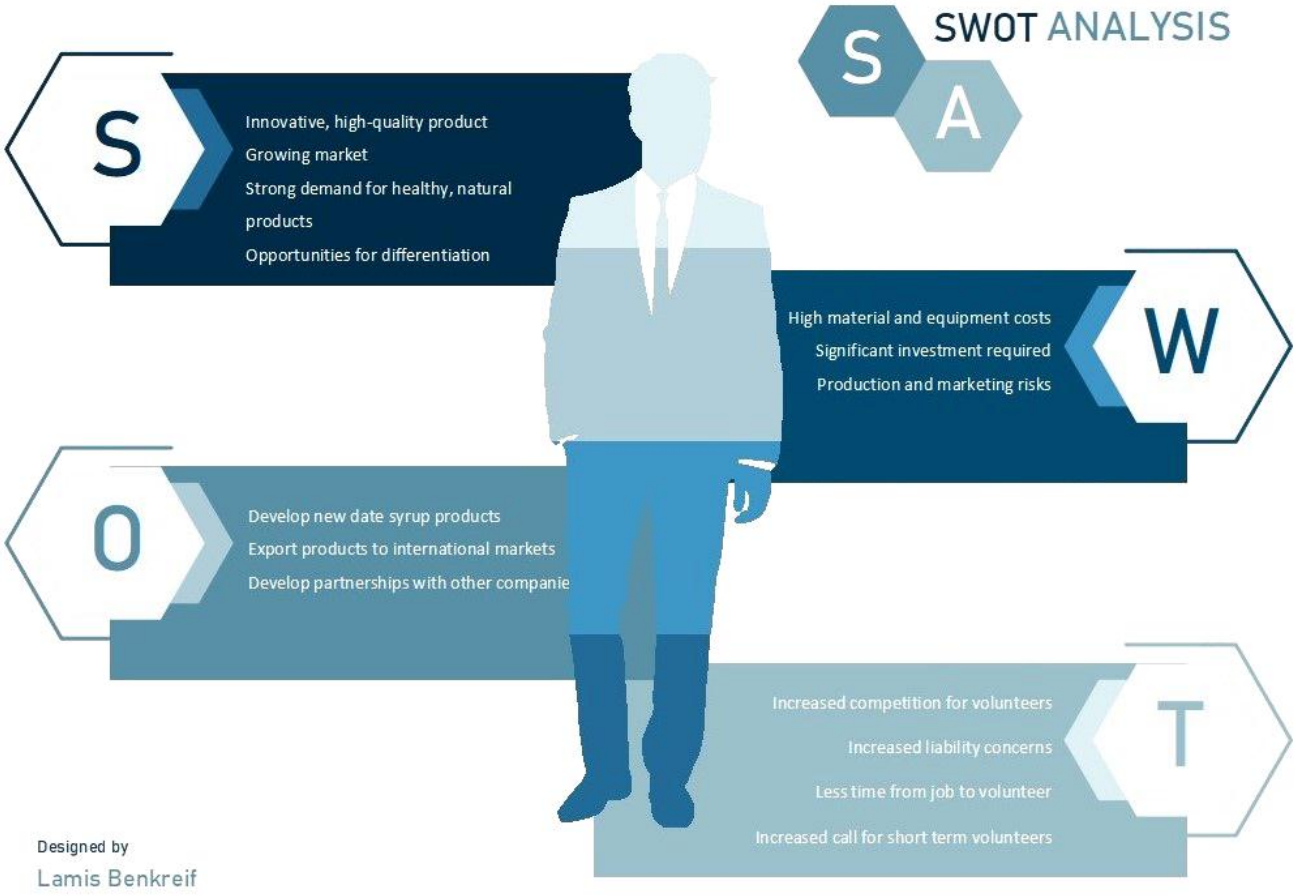

Figure 1: Diagram showing the diagnosis of our project using SWOT analysis_

3.2. Market analysis/study

This involves the use of various studies and research to understand the needs, and desires of customers and their opinions of our products and services. This type of research can be done through interviews, questionnaires, and online reviews.

Market demand for date syrup chocolate

-Demand for date syrup chocolate is growing, as consumers look for healthier alternatives to traditional chocolates.

-Date syrup is a natural, healthy ingredient with a unique taste and health benefits.

-Consumers are willing to pay more for high-quality chocolates made with organic, and sustainable ingredients.

3.3. The analysis of competitors

Through this, we study competitors in the market, discover what makes your product distinctive, and different from your competitors, study the marketing methods adopted by competitors and constantly monitor any changes in the market.

Assess competitors' strengths and weaknesses:

It's crucial to identify competitors' strengths and weaknesses to differentiate and position yourself effectively in the market.

- Competitors' strengths may include their brand, distribution, and market share.

-Competitors' weaknesses can include product quality, pricing, and innovation.

3.4. Improving the customer experience

The objective of enhancing customer experience is to foster a positive and memorable interaction at every customer touchpoint, thereby boosting satisfaction, loyalty, and advocacy. This goal can be effectively pursued through:

-Understanding customer needs and expectations;

-Streamlining processes, and procedures to make it easy for customers to interact with the company;

-Investing in customer-facing technology;

- Continuously measuring and evaluating customer satisfaction levels.

3.5. Marketing strategy

Digital marketing: Create an attractive, and informative website, use social networks to promote the product and engage customers, and collaborate with influencers to bring the product to a wider audience.

Traditional marketing: by participation in fairs and food shows, or distribute product samples in stores and public places or organize tasting and demonstration events.

3.6. Partnerships:

Agreements may be concluded with other partners, including retailers, to sell our products and market our services. This increases the number of potential buyers for the product and attracts customers.

Fourth axis: Production and organization plan

1. the stages of the production process

All these operations were made according to the standard of regulation and sterilization.

- **The manufacture process of date syrup**

The manufacture of date syrup is an ancestral recipe which is based on the use of artisanal materials in order to produce a better date syrup.

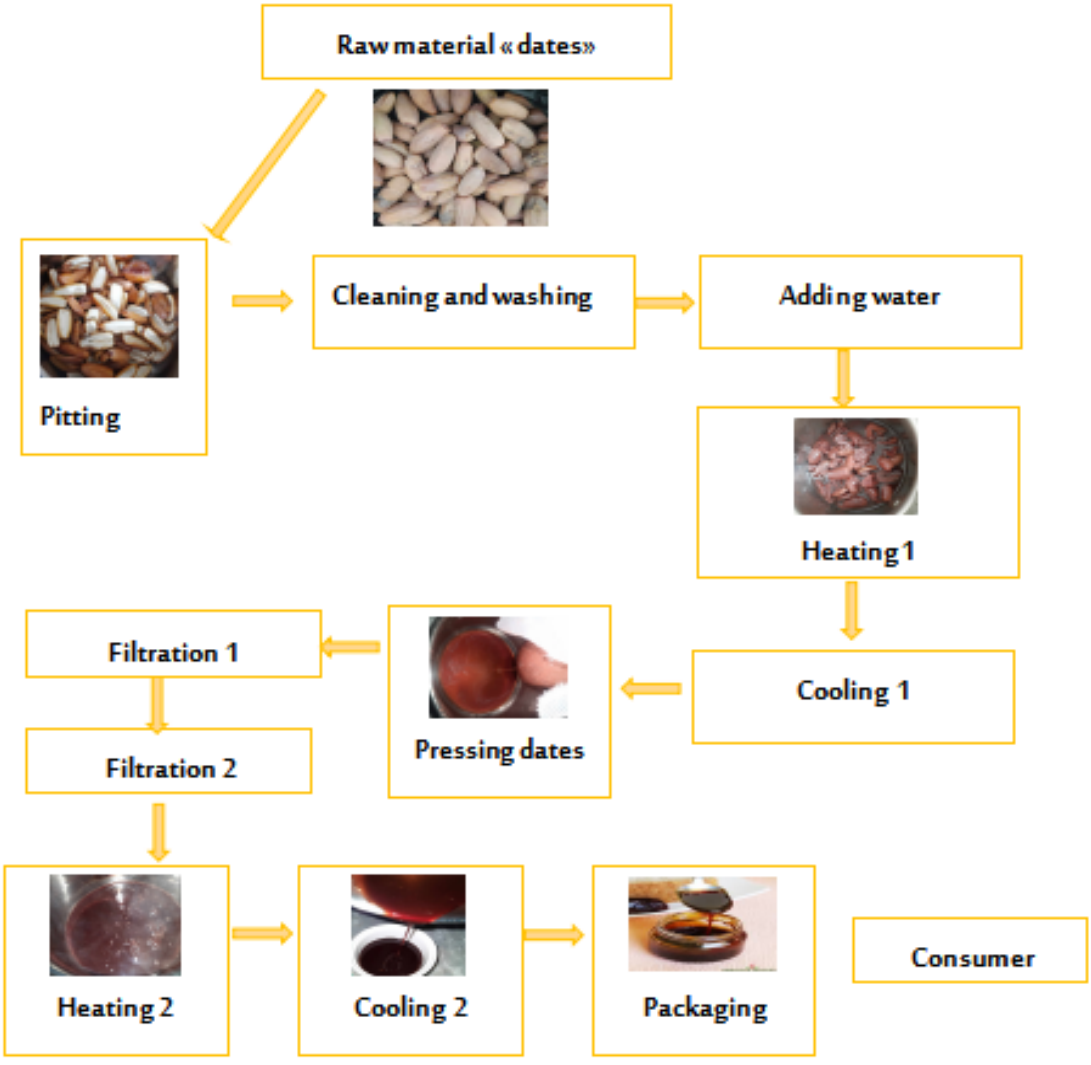

Figure 2: A schema about the manufacturing process of date

- The manufacture process of dark chocolate made by date syrup

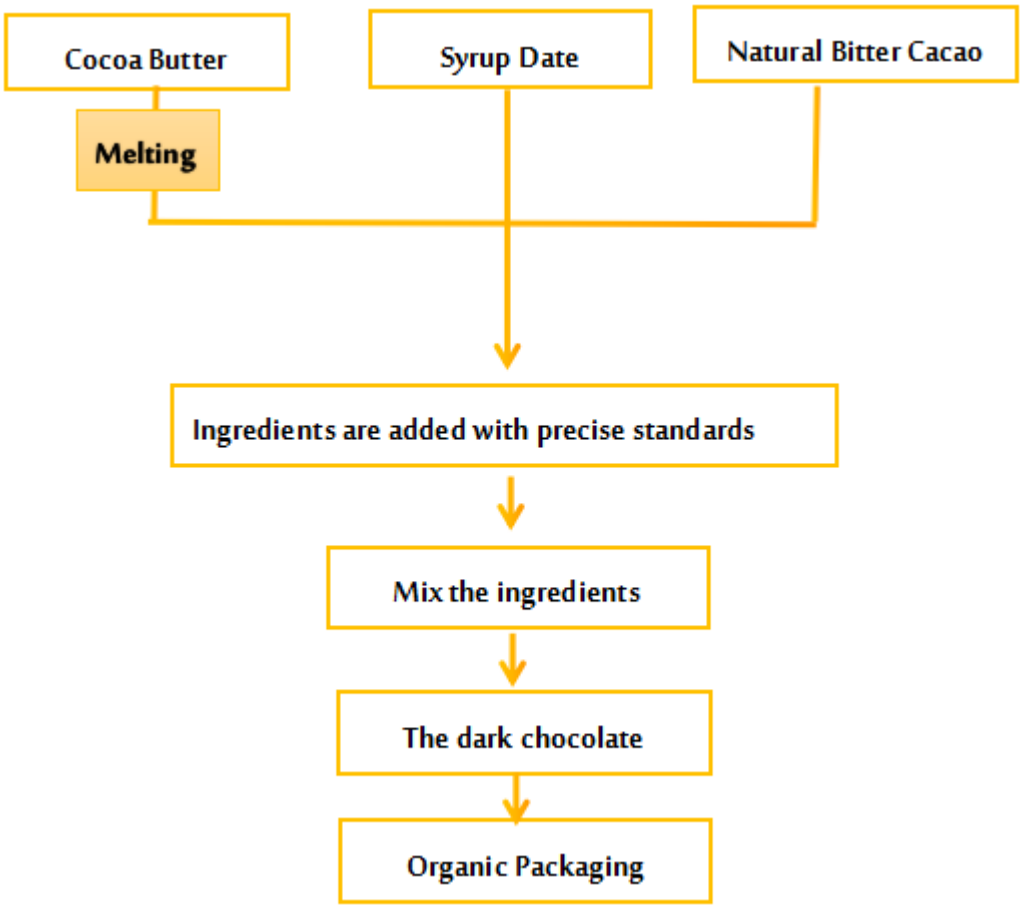

Figure 3: A schema about the manufacturing process of dark chocolate made by date

- **The manufacture process of coating chocolate made by date syrup**

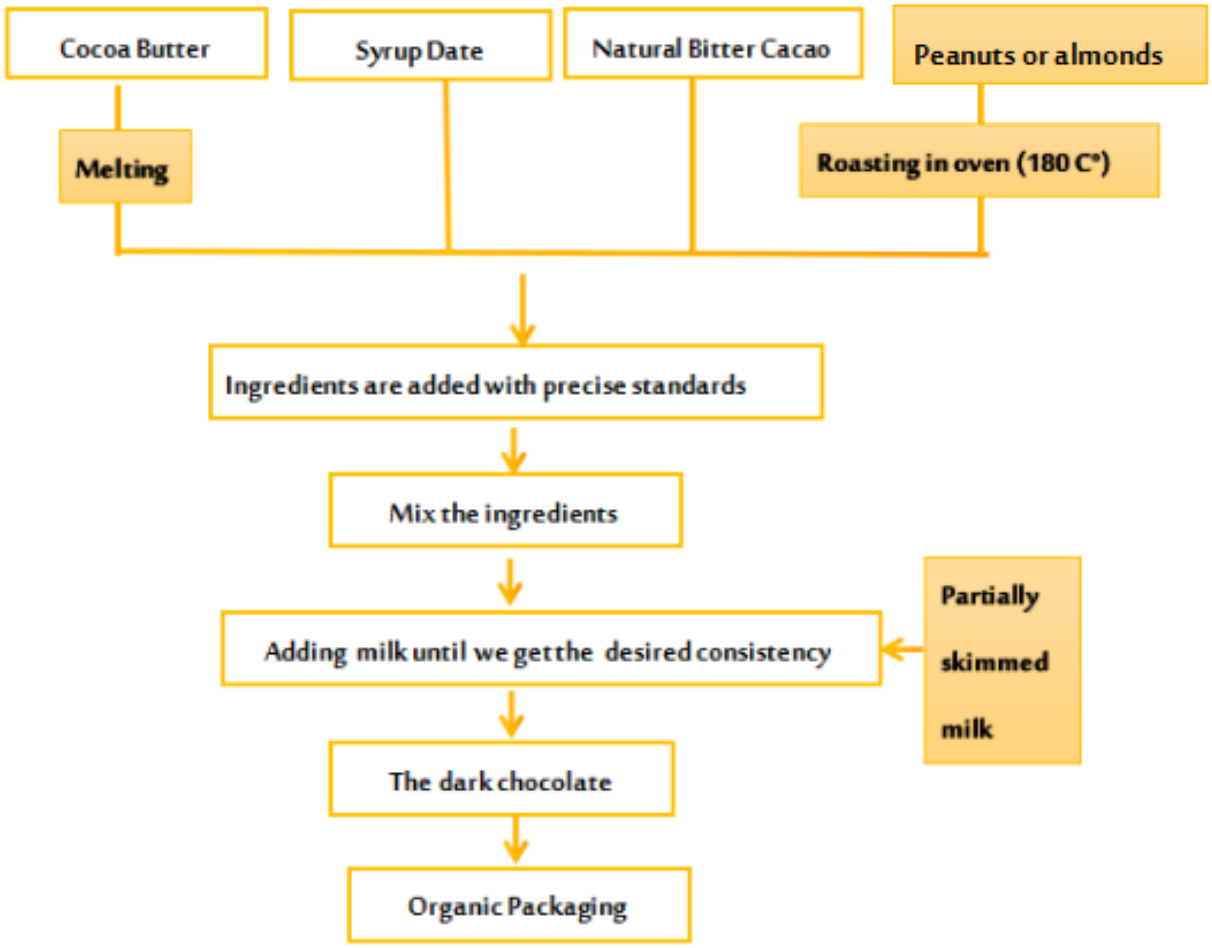

Figure 4: A schema about the manufacturing process of coating chocolate made by

2. **Supply**

- **determine the purchasing policy**

Purchasing raw materials: Raw materials will be purchased from local suppliers to ensure reducing costs and supporting the local economy. In addition to this, we purchase dates that are of little consumption in Algerian markets.

Obtaining production equipment: Equipment needed includes:

- ✓ Heating machines.
- ✓ Grinding machines.
- ✓ Mixing machines.
- ✓ Packaging machines.

Ensuring safe and clean production: Best practices will be followed to ensure the safety and health of the products.

Inventory Management: An effective inventory management system will be implemented to ensure the availability of raw materials and prevent any shortages.

- **The most important suppliers:**

- ✓ Companies selling natural Products.
- ✓ Gyms and supermarket.
- ✓ Farmers (to provide us with date).

- ✓ Packaging materials companies.
- ✓ Delivery companies.

- **The payment policy**

- ✓ Sales through direct contact with customers.
- ✓ Wholesale or retail.
- ✓ Sale via a website (online) , social networks(Facebook , Instagram) and application

6. Workforce :

Our project aims to generate wealth and job opportunities. (03) direct work positions according to the following tasks :

- Production worker: Those who work on the production line to mix the ingredients, pour the chocolate into the moulds, add the date syrup, and package the finished products.
- Machine technician: Those who operate and maintain the machines used in chocolate production, such as mixers, grinders and moulding equipment.
- Quality and control: Inspector and quality controller who check production standards and ensure that each batch of chocolate meets the required quality criteria.

The (04) indirect workforce is involved in supporting production operations, including:

- Administrative staff: Manage administrative tasks such as accounting, human resources and marketing.

- Maintenance staff: who carry out regular maintenance and repairs to equipment and facilities to prevent breakdowns.
- Supply and logistics department: These are responsible for purchasing raw materials (such as cocoa beans and date syrup) and managing stocks.
- Sales and marketing staff: Sell chocolate to customers.

7. The main partners:

The most important partnerships in our project are:

- For our project to be a success, we need a number of partners, including our university's incubator, which provides support at every stage, along with various training courses.
- suppliers (of raw materials), in view of the importance of their services to the success of the project
- Funding bodies: banks to provide funding for our project.
- Socio-economic partners to help launch the project.
- Quality Control Informant to provide technical expertise and effective resources in improving product production.

Fifth axis: Financial plan

Products		weight
Product A	Date syrup	170 g
Product B	Coating chocolate	170 g
Product C	Chocolate tablets	100 g
Product D	Chocolate bars	80 g

Note: The currency in Algerian dinars.

1/ Costs and burdens

- **Fixed costs :**

Element	The amount
Building	360 000.00 DA
Machines	3 000 000.00 DA
Transport	500 000.00 DA
Office equipment	340 000.00 DA

- **The variable costs for each month:**

Element	The amount
615 Kg Date	123 000.00 DA
129 Kg Cocoa butter	258 000.00 DA
81 Kg Cocoa powder	90 000.00 DA
21 Kg Hazelnut	56 400.00 DA
3000 Glass box of 170g	90 000.00 DA
1500 Plastic box	37 500.00 DA
1500 Packaging box	60 000.00 DA
Water and electricity	3 0000.00 DA
Labor	200 000.00 DA
Marketing	50 000.00 DA

- **The variable costs in one day:**

Element	The amount
20.5 Kg Date	4 100.00 DA
4.3 Kg Cocoa butter	8 600.00 DA
2.7 Kg Cocoa powder	3 000.00 DA
0.7 Kg Hazelnut	1 880.00 DA
Water and electricity	1 000.00 DA

- ✓ 410g of date give us 246g of date syrup.
- ✓ 246g of date syrup give us 100g of chocolate tablet, 170g of coating chocolate, 170g of date syrup and 80g of chocolate bars.
- ✓ 20,5 Kg of date produce in one day for us 50 of chocolate tablets, 50 plastic boxes of chocolate bars, 50 glass boxes of coating chocolate and 50 of date syrup.

Supply will be from the business incubator, and the import of money is through the following sales:

- ❖ Selling the date syrup
- ❖ Selling the different products of chocolate
- ❖ Investing in the remaining date kernel by selling them to companies that produce the date kernel coffee.

2/ Business number

- ✧ A 170g of date syrup sold at 200 DA.
- ✧ A coating chocolate costs 300 DA.
- ✧ A plastic box of 9 pieces of chocolate 230 DA.
- ✧ A chocolate tablet costs 250 DA.

50 Glass boxes of date syrup	10 000.00DA
50 Glass boxes of coating chocolate	15 000.00DA
50 Plastic boxes of chocolate bars	11 500.00DA
50 chocolate tablets	12 500.00DA

- ✓ Daily income: 49 000.00DA

- ✓ Annual income: 17 885 000.00DA

Product intended for customer	N	N+1
Quantity produced	18250	20000
Product sale	17 885 000.00DA	19 600 000.00DA
Global turnover	---	---

Sixth axis: The first experimental prorotype

1/ Date syrup prototype:

Figure5 : Date syrup prototype

2/ Chocolate bars prototype:

Figure6: Chocolate bars prototype

3/ Chocolate tablets prototype:

Figure7: Chocolate tablets prototype

4/ Coating chocolate:

Figure8 : Coating chocolate

Business model Canvas

<table>
<tr><th>Key partners</th><th>Key activities</th><th>Value propositions</th><th>Customer relationships</th><th>Customer segments</th></tr>
<tr><td rowspan="3">-Suppliers (raw materials or packaging Dealers)
-Dealers Farmers
-Sponsors
-Customers</td><td>-Production line
-packing line
-storage and transportation</td><td rowspan="3">-A healthy alternative product with an affordable price rich in important nutrients
-Reduce project costs as much as possible by using locally produced raw materials</td><td>-Build relationships with customers and suppliers and clients by maintaining regular communication and providing a special service (Food, energy with a low price.</td><td rowspan="3">-Target group:
patients suffering from anemia.
diabetics.
celiac patients.
people following a diet.
In geographical terms:
-we focus on dates with low interest for the market</td></tr>
<tr><td>Key resources</td><td>Channels</td></tr>
<tr><td>-Access to reliable suppliers.
-Rental of a store and a truck carrying raw materials.
-The production machines.
-Knowledge and the experience.
-Machines
-Packaging
-Transport trucks
-Water, electricity.</td><td>-Sales through direct contact with customers.
-Wholesale or retail
-sale via a website (online), social networks (Facebook, Instagram) and applications</td></tr>
<tr><th colspan="3">Cost structure</th><th colspan="2">Revenue streams</th></tr>
<tr><td colspan="3">Construction costs.
Costs of equipment for making chocolate).
Marketing costs.
Ingredient costs
Personal and labor costs.
Electricity costs, transport...etc
Cost: 10 390 000.00 DA</td><td colspan="2">Sale of food to local and international markets
Daily income: 49 000.00DA
Annual income: 17 885 000.00DA</td></tr>
</table>