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New formulation of a dietetic madeleine incorporated with peanut oil and Deglah Beidha powder

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فراح



Abstract

With the goal of developing dietary food products, we focused on replacing industrial oils and sugars with peanut oil and Deglah Beidha powder. In this context, we chose to formulate a new madeleine. In our study, we extracted peanut oil using the Soxhleht method and prepared Deglah Beidha powder by oven drying and were ground using an electric blender . To characterize our raw material, we performed physicochemical analyses on peanut oil and its antioxidant component composition using GCMS and its fatty acid profile using HPLC. In addition, the Deglah Beidha powder underwent further physicochemical ,and mineral characterization using atomic absorption spectrophotometry. Regarding the formulation of madeleines, we manufactured four different formulations according to their content of peanut oil and Deglah Beidha powder alone or in cooperation. Following the manufacturing, we compared between these formulations at the physicochemical, sensory and textural level. This comparison gave us an idea on the interest of the mixture between these substituents. For the results, peanut oil was characterized mainly by an acidity of 0.52 ± 0.01 and iodine value 92 ± 0.02 , it contains 27 identified antioxidant compounds, and linoleic acid (33.34%), oleic acid (33.45%) as dominant fatty acids. Regarding Deglah Beidha powder, it is characterized by $75.21\pm0.02\text{g}/100\text{g}$ and $7.15\pm0.01\text{g}/100\text{g}$. In addition, it is rich in calcium and magnesium. Our madeleine, which is incorporated with peanut oil and date powder (F3PD), was characterized by a pH of 6.77 ± 0.01 , a specific volume of 11.88 ± 0.05 (cm^3/g), and a score of 8.45 ± 0.76 out of 9 (Soft) with an overall acceptance of 6.97 ± 0.3 . Image J analysis showed a particle count of 63.66 ± 13.27 . Finally, the results collected are encouraging, indicating that the substitution was successful in producing a healthy dietetic madeleine.

Keywords: Peanut oil, Deglah Beidha powder, madeleine, dietetic.

ملخص

بهدف تطوير المنتجات الغذائية، ركزنا على استبدال الزيوت المهدرجة والسكريات الصناعية بزيت الفول السوداني ومسحوق الدقلة البيضاء. وفي هذا السياق، اخترنا صياغة مادتين جديدتين. في دراستنا، قمنا باستخراج زيت الفول السوداني باستخدام طريقة سوكللي وقمنا بإعداد مسحوق الدقلة البيضاء عن طريق التجفيف بالفرن والطحن بالخلط الكهربي. من أجل تحديد خصائص المواد الخام لدينا، أجرينا تحليلات فيزيائية وكيميائية على زيت الفول السوداني وعلى تواجد مضادات الأكسدة بواسطة GCMS وملف الأحماض الدهنية بواسطة HPLC. بالإضافة إلى ذلك، خضع مسحوق الدقلة أيضا إلى التوصيف الفيزيائي والكيميائي، والمعدني بواسطة مطياف الامتصاص الذري. فيما يتعلق بتركيب المادتين، قمنا بتصنيع أربع تركيبات مختلفة وفقاً لمحتواها من زيت الفول السوداني ومسحوق الدقلة البيضاء بمفردهما أو مع بعضهما. بعد التصنيع، قمنا بمقارنة هذه التركيبات على المستوى الفيزيائي والكيميائي والحسي والملمسي. هذه المقارنة أعطتنا فكرة عن مدى فائدة الخليط بين هذه البدائل. بالنسبة للنتائج، تميز زيت الفول السوداني بشكل رئيسي بحموضة 0.01 ± 0.52 وقيمة يود 0.02 ± 92 ، ويحتوي على 27 مركب مضاد للأكسدة تم تحديده. وحمض اللينوليك (33.34%) وحمض الأوليك (33.45%) كأحماض دهنية سائدة. أما مسحوق الدقلة البيضاء فيتميز بـ 75.21 ± 0.02 غ/100 غ من الكربوهيدرات و 0.01 ± 7.15 غ/100 غ كنسبة رطوبة. بالإضافة إلى ذلك، فهو غني بالكالسيوم والمغنيسيوم. يتميز المادتين الخاص بنا والتي تم فيها دمج زيت الفول السوداني ومسحوق التمر (F3PD) بدرجة حموضة تبلغ 0.01 ± 6.77 وحجم نوعي 0.05 ± 11.88 (سم³/غ) وتقييم 0.76 ± 8.45 من 9 (ناعم) مع قبول عام 6. 0.3 ± 97 . وأظهر تحليل الصورة J عدد الجسيمات 63.66 ± 13.27 . وأخيراً، فإن النتائج التي تم جمعها مشجعة للقول بأن الاستبدال كان ناجحاً في إنتاج مادتين مخصصتين للنظام الغذائي الخاصة.

الكلمات المفتاحية: زيت الفول السوداني، مسحوق دقلة بيضاء، المادتين، علم التغذية.

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Introduction

Introduction

Human diets include a variety of macro- and micronutrients, encompassing numerous vitamins, minerals, antioxidants, and other beneficial phytochemicals; all essential for maintaining a healthy life. Macronutrients provide different types of proteins, carbohydrates, fat and the food industry focuses on delivering these either as primary ingredients or as components of a wide range of products **(Gunstone, 2011)**. A balanced intake of macronutrients typically ensures the presence of necessary micronutrients as well.

Despite widespread misconceptions from unverified sources portraying fat as undesirable, it remains a crucial dietary component. The primary nutritional challenge today lies in raising awareness about both the quantity and the quality of fat intake. Lipids possess vital physical, chemical, and nutritional properties, and achieving the right balance among them is essential. Nutritionists recommend specific amounts and types of dietary fats, while seed producers, farmers, and food industry professionals work to meet these standards. Currently, there are growing concerns regarding high trans fat consumption which must be reduced and low omega-3 intake which needs to be increased along with the global rise in obesity **(Gunstone, 2002)**.

There are types of refined sugars, such as white sugar (sucrose), glucose syrup, and high fructose corn syrup (HFCS), which are used to improve taste, texture, and shelf life **(Kubala, 2018; Harvard Health, 2023)**. These sugars have a high glycemic index and are rapidly absorbed, making them among the health concerns in processed foods **(Ma et al., 2013)**. Diets high in added and refined sugars contribute to increased calorie intake without satiety, which can lead to several diseases and dental problems. They may also have a negative impact on cognitive health (such as impaired memory or concentration) **(Te Morenga et al., 2013)**.

In Algeria, studies have shown that local peanut varieties have good levels of monounsaturated fats, with low levels of free acidity (0.6–1.2%), indicating the high quality of the oil extracted from them **(Djeghim et al., 2015)**. Peanut oil, rich in monounsaturated fats and vitamin E, contributes to cardiovascular health and has anti-inflammatory properties. Its thermal stability makes it ideal for high-temperature cooking and baking **(Akhtar et al., 2014)**.

Dates have long been a vital part of human and animal diets, valued for their high nutritional and energetic content. They are particularly rich in natural sugars and essential minerals. Dry date varieties, including the Algerian Deglah Beidha, are densely packed with calories, containing more than 50% sugars relative to their dry weight. In Algeria, there are currently no advanced industries specializing in date transformation, except for basic packaging and the production of date paste (ghars) from soft varieties. Given their high sugar content, common dates offer a promising alternative to commercial white sugar (granulated or powdered), and their valorization could yield significant socio-economic benefits (**AlFaris et al., 2022**).

In recent years, there has been growing awareness of the health risks associated with the consumption of industrially processed foods, especially those containing hydrogenated oils and refined sugars. Hydrogenated oils, commonly used in baked goods to improve texture and shelf life, are a major source of *trans* fats (**Mozaffarian et al., 2006**). These fats are associated with elevated levels of low-density lipoprotein (LDL) cholesterol and reduced levels of high-density lipoprotein (HDL) cholesterol, contributing significantly to the risk of cardiovascular diseases (**Hu & Willett, 1997**). Additionally, processed sugars widely present in baked goods are linked to several health issues, including obesity, type 2 diabetes, and metabolic syndrome (**Malik et al., 2010**). Due to their high glycemic index, refined sugars cause rapid spikes in blood glucose levels, potentially leading to insulin resistance over time (**Gibbins et al., 2014; Rosenbaum & Leibel, 2015**).

For these reasons, this study aims to valorize one of Algeria's lesser-consumed, often discarded dry date varieties Deglah Beidha by incorporating its flour into biscuit production and evaluating consumer acceptance. In addition, given the abundance and high quality of peanuts in our region, we propose the inclusion of peanut oil in biscuit formulation as a healthier fat alternative. We selected Madeleine as the focus of our study. Madeleine are sweet, spongy snacks that are widely consumed and appreciated for their pleasant taste, soft texture and convenience (**Nurul Ain et al., 2016**). As a bakery product, their physical quality is primarily assessed based on key attributes such as appearance, color, and specific volume.

This document is organized into the following structure:

- The first part consists of a literature review divided into three chapters: the first covers general information about peanuts and peanut oil; the second discusses date palms and the Algerian white date variety (Deglah Beidha); and the third provides an overview of biscuits and baked goods;
- The second part is the experimental section, detailing the plant-based material used, the methods applied in the preparation of the madeleine, and includes a sensory evaluation test;
- The last part presents the results obtained, along with their analysis and scientific discussion.

Part01

BIBLIOGRAPHIC

Chapter I

General information about peanuts and peanut oil

I.1 History

The peanut is a tropical plant native to Latin America. It was cultivated upon the arrival of European explorers, from northern Argentina to Mexico and the Caribbean, and from Peru in the West to the Brazilian coast in the East. The spread of the peanut began around the 16th century. The plant then gradually covered all tropical, subtropical, and savanna areas (**Adrian and Jacquot, 1968; Schilling, 2003**).

The peanut is known by various vernacular names such as: groundnut, peanut, earthnut, monkey nut in English-speaking countries; arachide, cacahuète, cacahouète, pistache de terre in French-speaking countries; and Voanjo, Voanjombazaha, Voanjolava (Highlands) or Kapiky (South-West) in Madagascar (**Raobinarison, 1970; Ntare, 2007**).

I.2 Definition

The peanut, *Arachis hypogea* L., also known as groundnut, is a legume belonging to the *Papilionaceae* (*Fabaceae*) family. It is widely cultivated in tropical and subtropical climates and provides an oilseed used for making cooking oil. (**Clement, 1981**).

The peanut is an annual plant with a self-pollinating mode of reproduction. It grows to a height of 30 to 70 cm, with erect or creeping stems, continuous growth, and fruits that mature underground. Its vegetative cycle ranges from 90 to 150 days for the latest varieties. (**SCHILLING, 1996**). Under optimal conditions, the peanut completes its cycle in 90 days for early varieties, 120 days for semi-late varieties, and 140 days for late varieties (**Schilling, 1996**).

I.3 Origin

The peanut is a plant native to Brazil. Today, it has spread to the tropical regions of Asia and Africa. It seems established that the peanut originated in Tropical America: Peru, Brazil, or Argentina (**Clement, 1981**).

The origin of the peanut is uncertain. According to Chevalier cited by **IBRA. (1988)** there is a strong probability that this plant originated in South America since no spontaneous species are reported in Africa, whereas they exist in Brazil (**Ibra, 1988**).

The peanut is a tropical plant native to South America. The center of origin is located east of the Andes in a region between southeastern Bolivia, northwestern Argentina, northern Paraguay, and the western region of Matto Grosso in Brazil (**Ferguson et al., 2005**).

I.4 Morphology of the plant

The peanut is an annual herbaceous plant that self-pollinates (autogamous), growing to about 30 to 70 cm tall (**Figure 01**). It can have an upright or creeping growth habit, and it grows continuously. Uniquely, its fruit matures underground (**Schilling, 1996**).

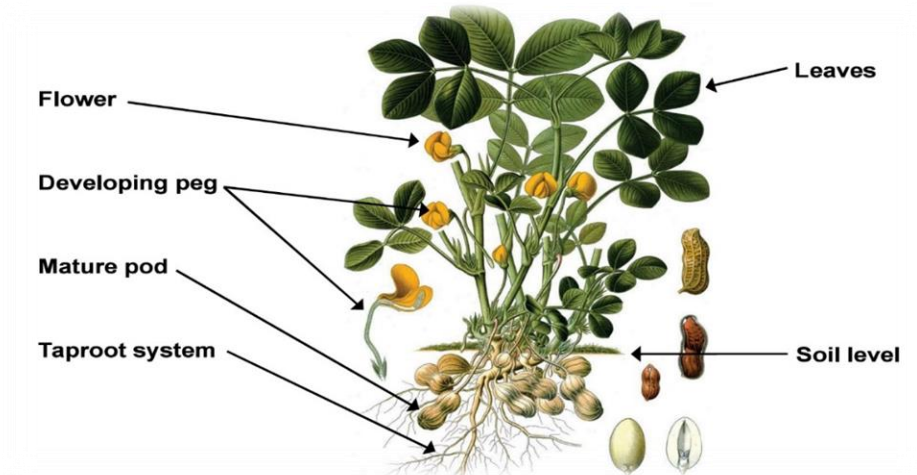


Figure 01: Representation of a peanut plant (*Arachis hypogaea. L*) (Snijman, 2022).

I.4.1 General Description

The peanut (also known as groundnut) is a legume, an annual plant with yellow flowers that grows to a height of 20 to 90 cm. The plant is able to withstand drought and heat, but it needs well-drained soil. It reaches maturity in about 100 days in a warm climate, which makes it particularly well suited to the rainy season. It is common practice to plant peanuts at the same time as other crops, such as sorghum, millet, wild peas, cotton, and vegetables (**Patrick, 2008**).

I.4.2 Root

The root system is powerful. It consists of a primary taproot that can reach up to more than 1 m in depth and numerous lateral roots forming a dense network that can extend up to 60-70 cm around the taproot. From the 15th day after emergence, the roots emit nodules that fix atmospheric nitrogen, a characteristic of legumes (**Raobinarison, 1970; Schilling, 1996**).

I.4.3 Leaves

The leaves are pinnate and have four leaflets. These leaflets are oval, arranged in opposite pairs, and are green in color, varying from lighter to darker shades. They are borne on a petiole (leaf stalk) that is 4 to 9 cm long. At the base of this petiole, two stipules (small leaf-like structures) are 2 to 3 cm long, partially fused to the petiole and sheathing the stem. The leaves exhibit both a diurnal (daytime) and a nocturnal (nighttime) position. During the day, the leaves are held erect, and the leaflets are wide open. At night, the petioles droop towards the ground, and the leaflets fold together in pairs. Variations in the arrangement of the leaflets occasionally result in leaves with five, three, two, or even just one leaflet (**Habou, 2003**).

I.4.4 Flowers

The peanut plant has two categories of flowers: aerial flowers and subterranean flowers. All of these flowers are of the papilionaceous type (butterfly-shaped), are fertile, and number 600 to 1000 per plant, but only 10 to 20% will produce pods and reach maturity. The aerial flowers, which are golden yellow in color, originate in the axils of the leaves. After fertilization, the base of the ovary elongates to form an organ called a gynophore, which burrows into the soil where the fruit develops. The subterranean flowers develop at the base of the stems. Some appear in the open air, while others remain underground (**Raobinarison, 1970**).

After fertilization, the flower withers and the base of the ovary elongates to form a long stalk called a gynophore, which buries itself in the ground where a fruit called a pod is formed. This pod consists of a husk containing one to five seeds. The husk, or pericarp, comprises an exocarp, a sclerenchymatous mesocarp, and a parenchymatous endocarp. The seeds vary in size, shape, and color depending on the variety; their weight can vary between 0.2 and 2 g.

I.4.5 Seeds

The shape can be spherical, elliptical, or more or less elongated with a part often flattened in the area of contact with the neighboring seed. The color of the seed coat is white, pink, red, or purplish (**Habou, 2003**). These are ovoid or cylindrical pods, 1 to 8 cm long and 0.5 to 2 cm wide. The pods are grouped at the base of the plant for erect varieties, or distributed along the branches for creeping varieties (**Ibra, 1988**).

There are 1 to 5 seeds per pod. They are formed of:

- * A pinkish or salmon-colored seed coat, sometimes with multiple colors.
- * An almond containing two cotyledons filled with fatty substances.
- * An easily distinguishable embryo.

Their weight varies from 0.2 to 2 g. The proportion of seeds to the weight of the entire pod varies from 68 to 80%. The germinating capacity of peanuts in the pod lasts for at least one year (**Hubert, 2000**). The peanut seed contains proteins and is rich in unsaturated fatty acids, represented by 60% oleic acid, and magnesium. It is also well-supplied with potassium, iron, phosphorus, and vitamins B, B7, B3, and E (**Ahleung et al., 2003**).

I.5 Classification of peanuts

I.5.1 Taxonomic classification

The table below present a systematic position of *Arachis Hypogea L.*

Table 01: Taxonomic classification of *Arachis Hypogea L.* according to **Hubert. (2000)**.

Reign	Vegetal
Branch	Phanérogames
Below Branch	Angiosperms
Class	Dicotyledons
Subclass	Rosales
Order	Fabale
Family	Legumes
Subfamily	Papilionaceae or Fabaceae
Gender	Arachis
Species	<i>Arachis hypogaea. L</i>

The species *Arachis hypogaea* is divided into two subspecies and three varieties corresponding to the Virginia, Spanish, and Valencia types (**Schilling, 1996**), which are in turn divided into different varietal subgroups according to the climatic and edaphic conditions specific to their development and cultivation (**Youssi, 2008**).

I.5.2 Commercial classification

Peanuts are consumed either as seeds, in the form of oil, or in other processed forms (butter, paste, flour, confectionery, etc.) (**Schilling, 2003**). Depending on their quality or ability to meet consumer requirements, the main peanut varieties in the world can be classified into three categories:

1. Edible or confectionery peanuts: These are used directly for consumption. These varieties have a low fat content (less than 50%) and a high seed weight (more than 150g per 100 seeds). They are often larger and more visually appealing;
2. Oil peanuts: These are the raw material for oil production. These must combine a high shelling yield (from 70%) with a high fat content (from 50%) (**FAO, 1991**);
3. Dual-purpose peanuts: These can be used both for direct consumption and for oil production. These have intrinsic characteristics of both edible and oil peanuts (**Youssi, 2008**).

I.6 Plant Chemistry

The peanut seed consists of relatively equal weights of oily and non-oily elements. It contains 47% fats, 26% protein, and 17 to 19% carbohydrates. The table 02 shows the composition of 100 grams of peanut seeds and their energy equivalent.

Table 02: Raw composition of peanut seeds (per 100g) (Knoden *et al.*, 2011).

Constituents	Raw with skin	Raw without skin
Water	5.66	5.4
Proteins	26	26.3
Fats	47.5	48.4
Carbohydrates	18.6	17.6
Fibers	2.4	1.9
Ashes	2.3	2.3
Minerals	1.15	1.15

I.7 Biological Properties of Peanuts

The health benefits of peanuts are numerous. These seeds are very rich in protein, monounsaturated and polyunsaturated fatty acids, and fiber. Peanuts reduce the risk of cardiovascular diseases and can combat certain cancer risks

Epidemiological studies associate regular peanut consumption with a decrease in blood cholesterol and the risk of cardiovascular disease. A chemical study on the effect of regular peanut consumption has shown an improvement in several blood parameters favorable to cardiovascular health.

A prospective study has associated peanut consumption with a lower risk of colorectal cancer in women. Peanuts also contain certain compounds that are potentially beneficial in cancer prevention in humans, and the phytosterols contained in peanuts are associated with a reduced risk of lung cancer (U.S. Department of Agriculture, n.d.)

I.8 Peanuts uses

Peanut is one of the main oilseeds consumed worldwide. It lends itself to numerous uses.

I.8.1 Human Food

The use of peanuts in food applications is now highly developed and is mainly processed into several derivatives that are used in food products.

- * Peanut seeds are a snack food (eaten between meals). They can be eaten whole fresh, but most often dried, roasted, and salted (**Novello and Santamaria, 2005**).
- * Peanut flour and peanut butter are used in the food industry for making biscuits (**Hubert, 2000**).
- * Peanut oil is highly valued in the manufacture of certain food products due to its very good resistance to high temperatures and its stability (**Schilling *et al.*, 1997**).

I.8.2 Animal Feed

Peanut cake (the residue of the seed after oil extraction), rich in protein (48 to 50%), is considered an important element in livestock feed (**Fonceka, 2010**).

I.8.3 Agriculture

Like all legumes, peanuts are a crop that enriches the soil with nitrogen. it can be used as green manure (**debbabie and shafchak, 2008**).

I.8.4 Medicine

- * Peanuts are used in the diagnosis of pimples and asthma attacks (**Hubert, 2000**).
- * Peanut oil is listed in the French pharmacopoeia as a medicinal solvent.
- * Cosmetic peanut oil is extracted by first cold pressing. It has detoxifying properties that make it perfect for massage against muscle pain. Also, it is rich in vitamins A and E. (**Cosmetic Ingredient Review Expert Panel, 2001**)

I.8.5 Other uses

In addition to its nutritional value, it should be noted that peanut shells can be widely used as fuel in developing countries where the energy problem is crucial. The grains contain 50% oil, which is used as a source of triglycerides for conversion to biodiesel (**Akba *et al.*, 2008**).

Thus, peanut derivatives can also be used as stabilizers and emulsifiers for food products, in the plastics and cosmetic cream industry, including shaving cream. Peanut pods are an excellent food source for fattening pigs, which are sometimes sent to the fields to feed directly on-site by uprooting the plants. The pod shells are also recovered for the manufacture of thermal insulation panels (**Mercola, 1997**).

I.9 Peanut oil

I.9.1 Definition

Peanut oil (PO), also called Arachis or groundnut oil, is a vegetable oil made from peanuts. This oil is highly regarded for its mild taste, high smoke point, and health benefits. Moreover, **PO** is used in soap production, cooking, shortening, and manufacturing margarine. **PO** is also commonly used in food processing. It also contains a high concentration of tocopherols (137-934 mg/kg) and sterols (900-4344 mg/kg), which have been demonstrated to boost immunity, lower blood cholesterol, prevent cancer, and improve oil oxidative stability. It also contains high levels of certain antioxidants. (**Akhtar et al. 2014**)

I.9.2 Type of peanut oil

I.9.2.1 Refined peanut oil

Refined peanut oil, like all processed vegetable oil, has been refined, bleached, and deodorized. This process removes the allergic protein component of the oil, making it non-allergenic, is a highly stable allergen-free and trans fat-free cooking oil that has a pleasant flavor, is very low in saturated fats (**Akhtar et al., 2014**)

I.9.2.2 Gourmet peanut oil

Gourmet roasted peanut oils are not refined and are considered specialty oils. Some of this gourmet peanut oil may be roasted, aromatic oil, which provides a wonderful peanut aroma and flavor to many food products. Gourmet peanut oil provides significant levels of vitamin E and phytosterols (**Peanut Institute, 2011**).

I.9.2.3 100% peanut oil

This type is highly aromatic usually called **100%** peanut oil, sometime it's blended with other oils. This type has a strong roasted peanut flavor and aroma usually consumed as flavoring compounds, confections, sauces, and baked goods (**Peanut Institute, 2011**).

I.9.3 Chemical composition of peanut oil

Peanut is an excellent source of nutrients, with a high fat, protein, and fiber content, and some carbohydrate, vitamins, and minerals. Peanut kernels' nutritional makeup was estimated in 1973 to be 6%–24% carbohydrate, 22%–34% protein, 44%–56% fat, and 5%–10% moisture(**Cobb and Johnson 1973**), and revised by other scholars as analytical tools develop. Moisture 4.9%-6.8%, carbohydrate 21%-37%, crude fiber 1.4%-3.9%, protein 20.7%-25.3%, ash 1.2%- 2.3%, and crude fat 31%-46% were recently reported ranges for peanut nutritional components(**Alhassan et al. 2017**).

I.9.3.1 Fatty acids composition

The composition of fatty acids in peanuts plays a vital role in their nutritional value and storage properties. Peanut oil contains saturated fatty acids accounting for approximately 11 to 17%, and unsaturated fatty acids comprise about 81 to 94% of the total fatty acid content. Peanut oil accounts for a considerable amount of the dry weight of the peanut seed, accounting for 44% to 56% of the total weight, and comprises several fatty acids. Palmitic (C16:0), stearic (C18:0), linoleic (C18:2), Oleic (C18:1), arachidic (C20:0), behenic (C22:0), gadoleic acid (C20:1), and lignoceric (C24:0) are the predominant fatty acids(**Casini et al., 2003**). In PO, approximately 80% of the fatty acids are unsaturated (UFA), and 20% are saturated (SFA)(**Cobb and Johnson, 1973**). Standard PO with The overview of fatty acid profile of peanut oil is presented in table 03.

Fatty acid	(Ozcan, 2010)	(Misuna <i>et al.</i> , 2008)	(Ozcan and Seven, 2003)	(Sander <i>et al.</i> , 1995)	(Hashmi <i>et al.</i> , 1993)	(Worthington <i>et al.</i> , 1975)
Palmitic acid	7.63-11.41	8.39-15.63	0.31-10.83	8.0-14.0	7.4-12.5	5.3-10.4
Stearic acid	2.14-4.13	3.56-4.76	0.1-4.23	1.0-4.5	2.7-4.9	2.2-4.4
Oleic acid	48.4-57.3	40.96-63.47	0.30-4.84	35.0-69.0	41.3-67.4	52.8-82.2
Linoleic acid	27.3-38.3	17-35-34.78	0.21-3.19	12.0-43.0	13.9-35.4	2.9-27.1
Arachidic acid	1.44-2.36	0.50-0.89	0.15-1.67	1.0-2.0	1.2-1.9	1.1-1.8
Eicosenoic acid	-	0.28-0.64	-	0.7-1.7	0.7-1.4	0.7-2.4
Behenic acid	-	1.75-2.33	0.31-2.43	1.5-4.5	2.1-3.6	2.2-3.9
Lignoceric acid	-	0.55-1.11	-	0.5-2.5	0.9-1.7	1.0-1.9

Table 03: Fatty acids composition of peanut oil (%).

I.9.3.2 Tocopherols

Tocopherol is an antioxidant that is capable of protecting cells from oxidative stress. Peanuts possess the highest levels of total tocopherols and specific tocopherols compared to other nuts. PO is rich in tocopherols; with α -tocopherol (20.21 mg/100 g), being the oil is most abundant (Akhtar *et al.* 2014). The antioxidant activities of tocopherols enhance the oil's ability to resist oxidation and rancidity. Moreover, the antioxidant properties of tocopherols in peanut oil have been shown

to help prevent diseases caused by oxidative stress, such as diabetes, cancer, and cardiac disease (Shahidi and Ambigaipalan 2015).

I.9.3.3 Phytosterols, Phospholipids, and Phenolics

Peanut oil contains several phytosterols, including β -sitosterol, stigmasterol, and campestral (Akhtar et al. 2014). Evidence shows that these compounds reduce cholesterol levels and may decrease the risk of cardiac diseases (Silva et al. 2020). There are also phospholipids (0.3– 0.7%) present in peanut oil (Akhtar et al. 2014). which are found to have antioxidant and antiinflammatory properties. Phospholipids reduce inflammation and improve cardiovascular health (Silva et al. 2020). Phenolic compounds found in peanut oil include resveratrol (Akhtar et al. 2014). It is antifungal, anti-inflammatory, antimutagenic, antiplatelet, and anticancer. It is also a powerful ROS scavenger, antioxidant, and metal chelator, among other things. Resveratrol inhibits lipid peroxidation, platelet and plasma protein oxidation, and nitration. (Olas and Wachowicz 2005).

I.9.4 Physical and chemical properties

The physical and chemical properties of fats and oils are determined by their fatty acid composition and their position within the triacylglycerol (TAG) molecule. Peanut oil is pale yellow in color with distinctive nutty taste and odor obtained from the processing of its kernel. However, refining may result in odorless oil (Sanders, 2002). Peanut oil is rich in oleic content that is associated with its good oxidative and freezing stabilities (Table 04).

Table 04 Physicochemical properties of peanut oil

Parameters	Value
Acid value (refined)	0.6 mg KOH/g oil
Hehner value	95–96
Iodine value (Wijs)	86–107
Peroxide value	1.0 meq peroxides
Polenske value	0.5
Viscosity (21.1°C)	70.7 mPas
Melting point of fatty acids	22–30°C
Moisture and volatiles	0.23%
Refractive index 40°C	1.46–1.465
Saponification number	187–196
Smoke point	226.4°C
Surface tension	35.6 Nm/m
Color (visual)	Light yellow

I.9.5 Nutritional properties and health benefits of peanut oil

Peanut oil is naturally trans fat free, cholesterol free, and low in saturated fats. It consists mostly of oleic acid (n-9), a monounsaturated fatty acid (MUFA) (52%), and linoleic acid (n6), a polyunsaturated fatty acid (PUFA) (32%) (**Beare-Rogers et al., 2001; Ozcan, 2010**). The oil is also a source of natural occurring compounds such as antioxidants, vitamin E, phytosterols, squalene, and p-coumaric acid, which are all beneficial in maintaining health. Peanut oil shows many positive biological effects, which are mostly connected with its high oleic acid content. A number of studies have shown the unique properties of this fatty acid and the importance of

maintaining its intake at as high level as possible. Oleic acid has been shown to have a positive influence on cardiovascular risk factors, such as lipid profiles, blood pressure, and glucose metabolism (**Ozcan, 2010**).

I.9.5.1 Anti-inflammatory activity

Peanut oil contains resveratrol that could effectively inhibit lipopolysaccharide (LPS)-induced nitric oxide (NO) production. This resveratrol perform effective anti-inflammatory activity. This compound might be of importance in further development for nutraceutical or chemopreventive applications (**Chang et al., 2006; Djoko et al., 2007; Kang et al., 2010**). Resveratrol treatment of mice presented protection against colitis through upregulation of SIRT1 in immune cells in the colon (**Singh et al., 2010**). Recently, it was invested that resveratrol, in an ex vivo model, inhibited tumor necrosis factor-R (TNF-R) and interleukin-6 (IL-6) released from macrophages, hence suppressing macrophage-CM-induced inflammatory response in adipocytes (**Djoko et al., 2007**). In addition, resveratrol exerts anti-inflammatory effects in microglia and astrocytes by inhibiting different proinflammatory cytokines and key signaling molecules (**Lu et al., 2010**).

I.9.5.2 Antitumor activity and anticancer activity

Peanuts and peanut oil contain different phytochemicals such as β -sitosterol, resveratrol, campesterol, and stigmasterol, this gives a strong evidence of protective role in different cancers like breast, colon, and especially prostate (**Awad et al., 2000; Lopes et al., 2011**). Unrefined peanut oil contains 207 mg PS/100 g; these higher values give confirmation of strong anticancerous property of peanut oil (**Awad et al., 2000**).

I.9.5.3 Protection against Alzheimer's disease

Peanut oil is a rich source of vitamin E and other phytochemicals. Niacin and vitamin E are two important constituents that provide protection against Alzheimer's disease. In almost 4000 people 65 years or older, niacin from food slowed the rate of cognitive decline (**Morris et al., 2004**). In another study, 815 people, 65 years or older without Alzheimer's disease, were followed for almost four years. Although the consumption of vitamin E from supplements had no effect on the incidence of Alzheimer's disease, vitamin E intake from food was protective (**Morris et al., 2002**). In those who were in the top fifth of intake, incidence of Alzheimer's disease was reduced by 70% (**Shin et al., 2009**).

I.9.5.4 Anti-diabetic activities

A study conducted on INS-1 (a rat pancreatic beta cell line) showed that oleic acid and peanut oil high in oleic acid were able to enhance insulin production. Pretreatment with oleic acid reversed the inhibitory effect of TNF- α on insulin. Peanut oil ultimately reversed the negative effects of inflammatory cytokines observed in obesity and noninsulin dependent diabetes mellitus. Type 2 diabetic mice that were administered a high-oleic acid diet derived from peanut oil had decreased glucose levels compared with animals given a high-fat diet with no oleic acid (**Vassiliou et al., 2009**).

Chapter II

General information about the date

II.1 Date palm

Phoenix dactylifera L., comes from the Phoenician word "Phoenix" which means date palm and dactylifera is derived from the Greek term "dactulos" which means finger, a reference to the shape of the fruit (Jarbi, 1994) (Figure 02).

The date palm is a tree that is probably native to the Arabian Gulf region, and is grown in hot and humid areas. It is a dioecious, monocotyledonous tree species, belonging to a large family of palm trees and produces dates (Giles, 2000; Mazower, 2002).



Figure 02: Date palm *phoenix dactylifera*

II.1.1 Botanical classification

The place of the date palm in the plant kingdom is presented below in table 05.

Table 05: Botanical classification of *phoenix dactylifera* according to **Djerbi.(1994)**.

Group	Spadiciflora
Order	Palmale
Family	Palmaceae
Subfamily	Coryphoidae
Tribe	Phoenicaceae
Genus	Phoenix
Species	Phoenix dactylifera.L

The genus Phoenix includes at least twelve species, the best known is the dactylifera, and whose "date" fruits are the subject of significant international trade (**Espiard, 2002**).

II.1.2 Definition and description of the date

The date, fruit of the date palm, is a berry, generally elongated or rounded. It is composed of a stone with a hard consistency, surrounded by flesh.

The edible part of the date, called flesh or pulp, is made up of:

- An epicarp or thin cellulose envelope called skin;
- A generally fleshy mesocarp, of variable consistency depending on its sugar content and is of a strong color;
- An endocarp of a lighter color and fibrous texture sometimes reduced to a parchment-like membrane surrounding the stone (**Espiard, 2002**).

The dimensions of the date are very variable, from 2 to 8 cm in length and a weight of 2 to 8 g depending on the variety. Its color is variable even when ripe, from golden yellow to dark red almost black. Its taste, shape, consistency and appearance vary enormously depending on the location and the cultivar (**Benchelah and Maka, 2006**) (**Figure 03**).

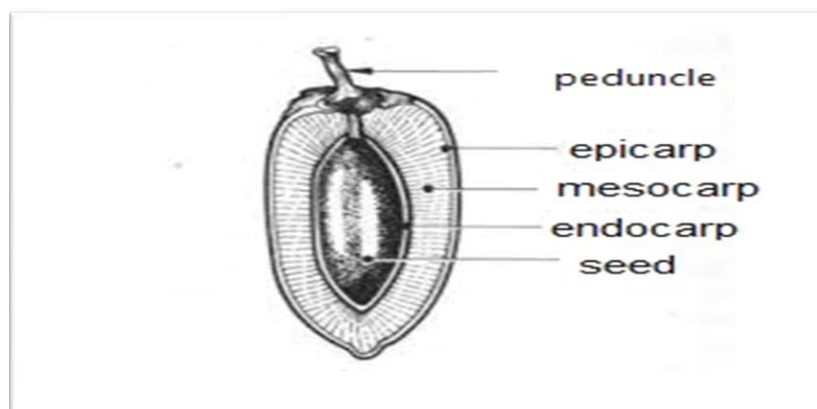


Figure 03: Longitudinal section of a date (Richarde, 1972).

II.1.3 Date formation and maturation

During its formation and maturation, the fruit goes through a number of phases, summarized in four stages called by their Arabic names: *Kimri*, *Khalal*, *Routab* and *Tamar* (Booij *et al.*, 1992). Different stages of date development can be distinguished (Sawaya *et al.*, 1983; Al Shahib *et al.*, 2003); each stage has a particular name depending on the country. In Algeria they are: *Loulou*, *Khalal*, *Bser*, *Martouba* and *Tmer*; however, the majority of authors have adopted the terminology used in Iraq and many Arab countries (Mennad, 2020).

II.1.4 Varieties of dates

They are very numerous and differ in their flavors, consistencies, shapes, colors, weights and dimensions (Belguedj, 2002). According to the same author; in Algeria, there are more than 940 cultivars of dates and the main cultivated varieties are:

-Deglet-Nour: Commercial variety par excellence. It is a semi-soft date, considered to be the best variety of date because of its appearance, its smoothness and its flavor. When ripe, the date is a brown amber color with a smooth, slightly wrinkled and shiny epicarp, the mesocarp has a fine, slightly fibrous texture (Noui, 2007).

-Common varieties: These varieties are of lesser economic importance compared to Deglet-Nour. The most widespread varieties are: *Ghars*, *Degla-Beidha* and *MechDegla*. According to Belguedj. (2001), a large proportion of common varieties are of soft consistency.

-Degla Beidha: It is tapered in shape, flattened on the perianth side and narrowed on the other end. At the *Bser* stage, it is yellow in color, become light brown to beige at the *Rotab* stage. At full maturity, it is beige in color. The epicarp is thick and smooth. The mesocarp is fleshy, dry in consistency and floury in texture. The calyx is flat, yellow to orange in color and adheres strongly to the flesh.

II.1.5 Chemical composition of dates

The pulp of the date represents a proportion of 80 to 95% of the total weight of the fruit depending on the variety and the pedoclimatic conditions. It is distinguished by its high humidity rate and its high sugar content (**Yahiaoui, 1998**). Water content The water content depends on the variety, the stage of maturation and the climate (**Daas, 2009**). It varies between 8 and 30% of the weight of the fresh flesh with an average of about 19% (**Noui, 2007**).

II.1.5.1 Sugars

Sugars are the major constituents of the date. Analysis of date sugars has revealed essentially three types: sucrose, fructose and glucose (**Estanove, 1990; Acourene and Tama, 1997**). This does not exclude the presence of other sugars in small proportions such as: galactose, xylose and sorbitol (**Favier et al., 1993; Siboukeur, 1997**). The total sugar content is very variable, it depends on the cultivar and the climate. It varies between 70 and 90% of the weight of the dry matter (**Siboukeur, 1997; Belguedj, 2001**).

II.1.5.2 Proteins

Dates are characterized by a low protein content. It varies between 0.38 and 2.5% of the dry weight (**Razi, 1993**). Despite this low content, the proteins of the date are qualitatively balanced (**Yahiaoui, 1998; Kendri, 1999**). The amino acids have many important biological functions. They often play the role of chemical messengers in communication between cells (**Donald and Judith, 1998**).

II.1.5.3 Fats

The date contains a small amount of fats, the rate of which varies between 0.43 and 1.9% of the fresh weight (**Biglari et al., 2008**). This content depends on the variety and the stage of maturation (**Yahiaoui, 1998**), it is concentrated in the flesh (2.5-7.5%) and plays a more physiological than

nutritional role, this role is reflected by the protection of the fruit against the proliferation of microorganisms (**Bousdira, 2007**).

II.1.5.4 Fibers

The date is rich in fibers. It provides 8.1 to 12.7% of the dry weight, (**AL-Shahib and Marshall, 2002**), the parietal constituents of the date are: pectin, cellulose ,hemicellulose and lignin (**Benchabane, 1996**).

II.1.5.5 Mineral elements

The study of 58 cultivars of dates grown in the Ziban region by **Acourene et al. (2001)**, shows that the ash rate is between 1.10 and 3.69% of the dry weight, Dates can be considered as fruits rich in mineral elements and therefore constitute a more interesting food, the mineral element content is 2 to of the dry weight of dates without pit (**Chahata, 2000**).

II.1.5.6 Vitamins

Date pulp contains vitamins in quantities that vary with the types of dates and their origin. In general, it contains carotenoids and B vitamins in appreciable quantities, but little vitamin (**Munier, 1973**).

II.1.5.7 Pigments

The main pigments identified in dates are: carotenoids, anthocyanins flavones, flavonols, lycopenes, flavoxanthin and lutein in certain Egyptian varieties (**Barreveld, 1993**).

II.1.5.8 Phenolic compounds

Dates contain secondary metabolites called phenolic compounds. Qualitative analysis of date phenolic compounds revealed the presence of cinnamic acids flavones, flavanones and flavonols. (**Mansouri et al., 2005**).

II.1.6 Nutritional value of dates

The date is an excellent food, with high nutritional and energy value (**Toutain, 1979; Gilles, 2000**). The high sugar content gives these fruits a high energy value. An interesting content of reducing sugars easily assimilated by the body. The proteins in dates are qualitatively balanced, but in small quantities.

A significant contribution of mineral elements. Dates are rich in plastic minerals: Ca, Mg, P, S and in catalytic minerals: Fe, Mn. They are remineralizing and significantly strengthen the immune system (**Albert, 1998**). The vitamin profile of the date is characterized by appreciable contents of vitamins of group B. This vitamin complex participates in the metabolism of carbohydrates, lipids and proteins (**Tortora and Anagnostakos, 1987**).

Chapter III

General information about madeleine

III.1 Definition of madeleine

The French word *gâteau* is even less specific than the English word "cake". It can be small cakes or biscuits like madeleines, large iced cakes, or even pastry confections like a king cake or a Saint-Honoré cake (Ameur and Lemmadi, 2019).

Madeleines are a sweet, spongy breakfast or evening snack traditionally prepared from wheat flour, sugar, oil/fat, milk, and eggs. The dough formation of madeleines is obtained by mixing an oil-in-water emulsion composed of a flour base that is incorporated with fat and sugar as primary ingredients and secondarily with eggs, milk, and other components (Martinezcervera, 2013).

Madeleines are a favorite baked product among consumers, due to their good taste and texture, in particular; the presence of a porous structure and high volume, which gives it a soft texture (Yena *et al.*, 2019).

III.2 Consumption of madeleine around the world

Traditionally in Spain, baked goods, especially muffins are a food consumed at breakfast and snack time, its soft and spongy texture turns it into a food widely consumed by the entire population and especially for children and the elderly (Martinez, 2013). Still linked in the mind of the consumer as a delicious product with special organoleptic characteristics (Hernando, 2016). Indeed; in recent decades, there has been a decrease in the consumption of bread that coincides with an increase in the consumption of pastry products. The main nutritional difference between these products is the amount and type of fat that they contain; Bread is a product with little or no fat concentration while bakery products are generally composed of a wide range of products rich in sugars and fats, particularly high in saturated fatty acids.

III.3 Contribution of ingredients in the assessment of the quality of madeleine

The quality of cakes is affected by many factors such as the quality and quantity of ingredients used, processing conditions, baking and cooling of biscuits (Devi and Khatkar, 2016). The typical formulation of madeleine is composed of wheat flour, sugar, eggs, milk and oil. All these ingredients have different contributions to the sensory qualities appreciated by consumers. Knowing the interactions between ingredients is possible to predict changes in their characteristics or to reformulate new products. Quantitatively; fat is one of the main ingredients that have an

influence on the overall biscuit texture. **Devi and Khatkar. (2016)** they provide characteristics such as tenderness, lubricity, flavor and a stable structure for biscuit (**Hasmadi and Hill, 2012**).

III.3.1 Flour

In cake recipes, wheat flour is the most widely used flour in the world flour plays a triple role:

- It is a source of hydrocarbon food for yeasts during fermentation;
- It participates in the Maillard reaction through its reactions with proteins in the formation of the color, odor and flavor of baked biscuits;
- It plays an important role in the mechanical characteristics of the dough and on its texture to form almost the entire final skeleton of the biscuit.

III.3.2 Fat

Fats play several major roles in biscuit technology:

- They increase the plasticity of the dough, which results in a decrease in consistency without adding additional water that would have to be evaporated during baking;
- They have a very high coefficient of thermal conductivity, which allows rapid transmission of heat through the dough;
- They prevent any tendency for the dough to stick;
- They improve the texture and color of the madeleine;
- They increase the nutritional value of the biscuits with the contribution of additional calories (**Randriamamplanina, 2011**).

III.3.3 Sugar

Contribute to the taste and aroma of the biscuits (provided by the Maillard reaction) and depending on their origins and uses, they develop color and give crispness to the decorations (**Anonymous, 2009**).

The Maillard reaction is a non-enzymatic chemical reaction that occurs between amino acids and reducing sugars when exposed to heat. This reaction results in the formation of brown colors and complex flavors characteristic of cooked foods.

Sugar is very important in biscuit making, it influences the plastic properties of dough, facilitates the incorporation of air which will be used for the regular rising of the product, improves the stability of biscuits relative to the rancidity of their fats and by its solidification; after cooling following cooking, it makes the biscuits non-deformable and more or less hard (**Anonymous, 2009**). It facilitates the absorption and retention of air during the creaming of fats, which will later be used for the rising of the product (**Bouhekioua, 2008**).

III.3.4 Eggs

Eggs provide lightness and "foaming" to recipes, such as for boudoirs, madeleines, meringues and sponge cakes. Eggs, in powder form, are less susceptible to microbial attack and easier to store (**Anonymous, 2009**).

Eggs contribute to the appreciation of interesting functional properties, improving the color and appearance of the final product (**Casas *et al.*, 2015**). When baked, the protein in the egg white coagulates to structure the dough and produces a muffin that breaks easily without excessive crumbling. On the other hand, the addition of egg yolk acts as an emulsifier and contributes to the mouthfeel (**Hui, 2006**). The presence of sucrose in muffin dough has an impact on these foaming properties, moreover; it increases the viscosity of the dough and its textural stability (**Thibault *et al.*, 2019**).

III.3.5 Baking powder

The addition of baking powder to the madeleine dough plays an important role in the expansion of its volume which is due to the release of steam (H₂O vapor) and the production of CO₂. When CO₂ is released before baking, the inflated gas cells diffuse through the dough and are lost on the surface (**Thibault *et al.*, 2019**).

III.3.6 Salt

Its roles in biscuit making are:

- It improves the flavour of the biscuit by better externalising the flavours added during the formulation of the dough;
- It strengthens the gluten in the case of weak flours by immobilising a certain quantity of free water in the dough (**Randriamamplanina, 2011**);

-A crust without salt will give a flat-tasting crust. However, its omission does not affect the mechanical aspects of the dough (**Ameur and Lemmadi, 2019**).

III.3.7 Milk powders

Milk is necessary for the solubilisation of the ingredients, for the hydration of proteins and carbohydrates and for the development of a gluten network. It affects the nature of the interactions between the various constituents of the formula and contributes to the structuring of the dough. It is also an essential factor in the rheological behavior of doughs. Milk improves cooking by its fat which transmits calories better. It also causes a greater whitening of biscuits after cooking by a more moderate, homogeneous and pleasant coloring of lactose compared to glucose. Finally, it improves the nutritional and dietary quality of the finished product (**Randriamamplanina, 2011**).

III.4 Biscuit quality assessment criteria

The quality attributes of food products include taste, aroma, texture, color and nutrient content. In most cases, these attributes begin to decline as soon as another raw material or ingredient is added to the biscuit (**Floros et al., 2010**).

1. At physicochemical level

-Final humidity: The final water content is important to assess when storing cereal products, since its quality is affected by its moisture content, which implies changes in the product, thus reducing the acceptability of the product by the consumer) Bourekoua, **2018**).

-Texture: Texture is an important property of the final quality of biscuits that strongly influences its acceptability by the consumer.

2. At Organoleptic level

It is well known that sensory properties strongly depend on the ingredients used and the preparation conditions, thus affecting the choice of consumers (**Bourekoua, 2018**). Biscuits must meet consumers' expectations (regarding shape, color, texture and taste) (**Tharraul, 1997**).

-Color: Color is a determining factor in defining the quality of any food and is a trait that the consumer immediately notices as it influences the subjective sensory impression (**Lara et al., 2011**).

-Taste, flavor and aroma: Taste attributes are salty, sweet, bitter and sour. Volatile aroma components are produced by heat, oxidation, non-enzymatic activity on proteins, fat and carbohydrates (e.g. Maillard reaction) (**Fellows, 2000**).

Part 02

Practical Part

Chapter 01

Material and methods

This project aims to produce a new madeleine formulation by substituting refined vegetable oil with crude peanut oil extract and industrial sugars with Deglah Beidha powder. This new product is qualified as healthy. Furthermore, the study aims to test the degree of acceptability of the product among tasters and to complete the characterization with physicochemical and textural analysis.

Our work is divided into four stages (**Figure 04**):

- 1 .Preparation of the raw material (selection, drying, and extraction);
- 2 .Characterization of the raw material (Deglah Beidha powder and peanut oil);
- 3 .Formulation of the madeleines;
4. Characterization of the quality of the formulated madeleines.

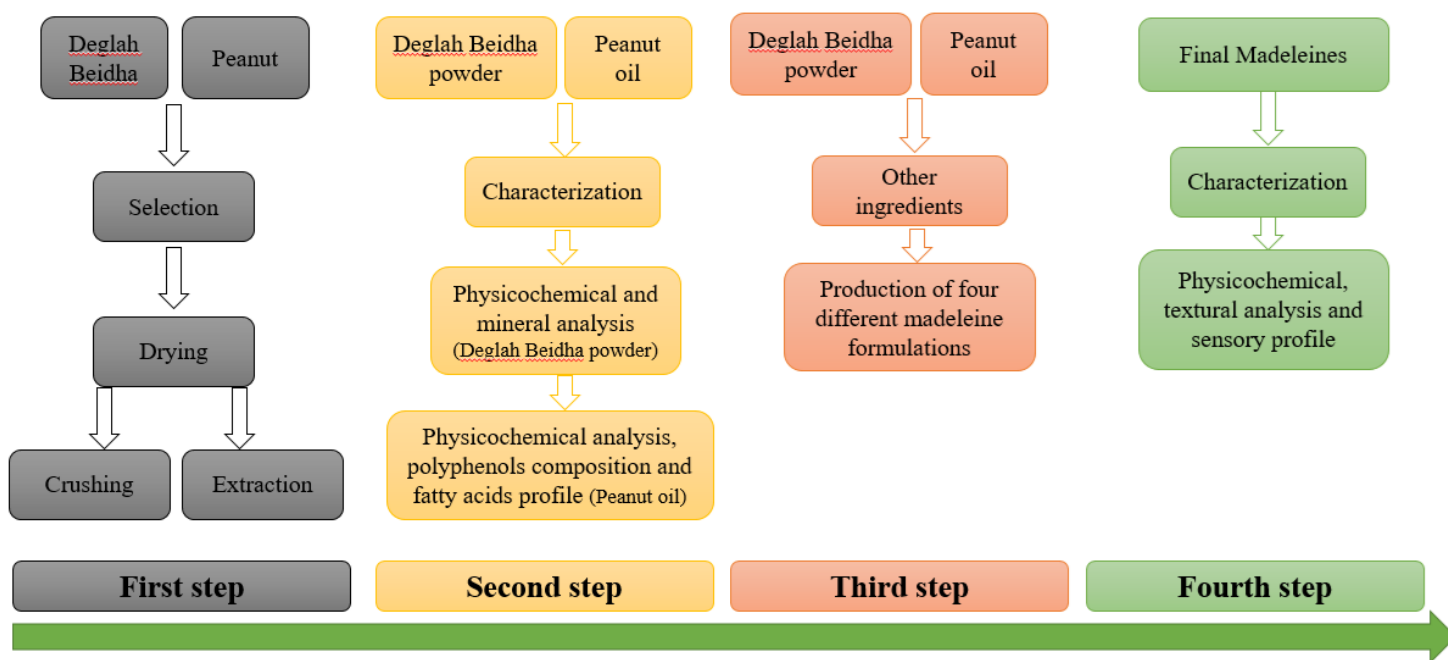


Figure 04: Experimental diagram of the study

I. Materials

I.1 Biological Materials

I.1.1 Peanuts

The peanuts were grown in the El Oued region and collected from Ouermas and Hassi Khelifa. The peanut selection was based on:

- Given the abundance and high quality of peanuts in our region.
- They are known for their richness in unsaturated fats and antioxidants.

I.1.2 Deglah Beidha

During our experimentation, we utilized a dry date variety known as "Deglah-Beidah." (Figure 05). This variety is harvested at full maturity and stored at 6°C until its processing and/or analysis, with the aim of slowing down respiration as well as minimizing physical and physiological changes. The dates were purchased from a merchant at the Libya market, who had sourced them from a farm owner in Hassi Khalifa, located in the El Oued province, during 10 November 2024. Subsequently, they were stored in the dark at 6°C in food-grade packaging.

The selection of this variety is justified by the following criteria:

- Its gustatory quality, its abundance at the national level, and its ease of preservation (as a dry date).
- Its richness in natural sugars, which can serve as a substitute for refined white sugar.
- Its significant technological value as a dry date (with a low moisture content of less than 20%).
- Its availability and low market value.



Figure 05: Deglah Beidah variety **(Personal image).**

I.2 Instruments, Equipment, and Chemicals Used

All instruments and equipment used during the characterization of the raw material, as well as the finished madeleine products, are presented in (table 06). The latter also lists the various chemicals required.

Table 06: Instruments, equipment, and chemicals used during the experimental study;

Instruments	Equipments	Chemical products
Test tubes	Drying chambers	Ethanol
Graduated burette	Oven	Potassium Hydroxide
Volumetric pipette	Soxhlet,	Hydrochloric Acid
Beaker	pH meter, Refractometer	Potassium iodide
Erlenmeyer flask	Precision balance	Acetic Acid
Sterile container	Water bath	Phenolphthalein
Magnetic stirrer bar	Flame absorption spectrophotometer	Chloroform
	Gas Chromatography- Mass Spectrometry (GCMS)	
	High-Performance Liquid Chromatography (HPLC)	

II.Methods

In this section, we will delve into explaining the different methods for the parts announced in the experimental diagram.

Part I: Study of the Raw Material

I.1 Drying of peanuts

The device used is illustrated in (figure 06). It is a direct solar dryer with natural convection, consisting of a single unit that functions as both a drying chamber and a solar collector.

The bottom of the drying chamber is painted black to increase its heat absorption capacity. This chamber is covered by a transparent material (glass) inclined at an angle of 31.57 degrees to capture solar radiation (the greenhouse effect). It is equipped with a chimney for the natural evacuation of humid air.

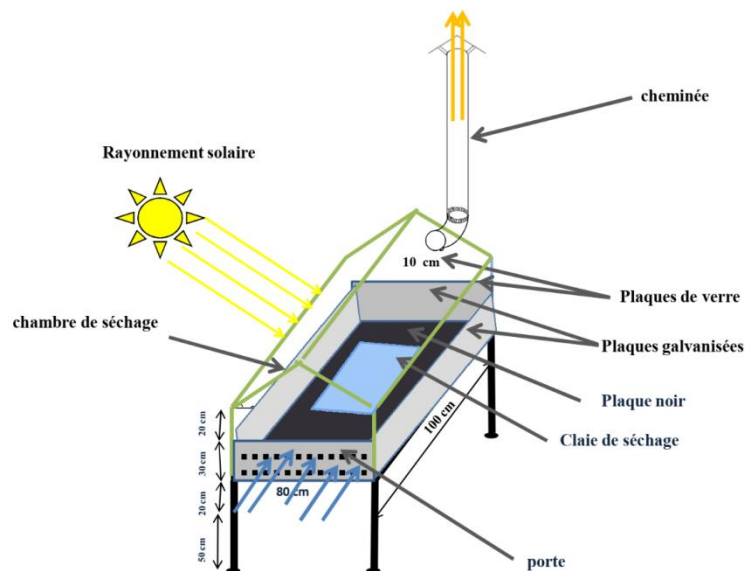


Figure 06: Solar dryer in greenhouse.

- **Operating principle**

The solar drying of peanuts utilizes this concept to accelerate the process of removing water contained within the dehydrated peanuts. The heating of the peanut surface, thanks to solar radiation and infrared radiation emitted by the transparent material of the greenhouse, increases the water vapor pressure on the peanut surface, consequently promoting evaporation. A flow of fresh air admitted under the greenhouse allows for the evacuation of water vapor.

- **Product preparation**

Before starting the drying operation, it is necessary to sort the peanuts, selecting samples of the same volume in each experiment.

I.2 Peanut oil extraction

In this stage, we extracted peanut oil from moist peanut grains and those dried by direct solar drying, using hexane (figure 07).

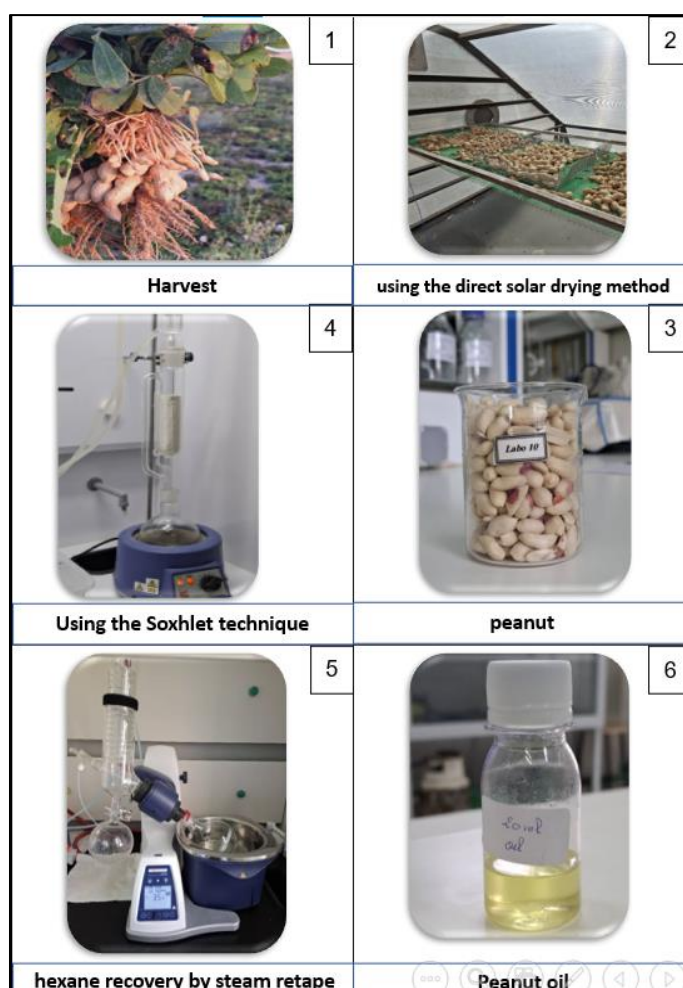


Figure 07: Different stages of peanut oil extraction.

I.2.1 Sample Preparation

In our study, we sorted a quantity of peanuts to ensure the sizes and weights were approximately similar. Then, we dried them and removed the peanut shells. Finally, we ground the grains using a blender to obtain homogeneous particles.

I.2.2 Soxhlet extraction

This is a solid-liquid extraction process. The Soxhlet extractor allows for the treatment of solids of all sizes with solvents in the liquid or partially vaporized phase.

The body of the extractor (Soxhlet), containing a cartridge holder filled with the solid, is fixed onto a solvent reservoir (flask) and topped with a condenser. The solvent is vaporized and then condensed, remaining in contact with the solid. The solution is periodically drawn off by the priming of a siphon. The solution in the flask gradually becomes richer in solute, and the solid is always brought into contact with freshly distilled solvent (Tedjini, 2006)

I.2.3 Characterization of peanut oil

I.2.3.1 Physicochemical analysis (Details in the appendix)

I.2.3.1.1 pH

Since oil does not contain water and cannot be tested directly for pH, a simple emulsion is prepared by mixing oil with distilled water. The pH of the aqueous phase is then measured using a calibrated pH meter

I.2.3.1.2 Degree of acidity

The acid number is defined as the number of milligrams of potassium chloride needed to neutralize the free fatty acids in one gram of oil. The higher the acid number and the percentage of free fatty acids, the higher the rate of rancidity of the oil. The acid number is calculated by the relationship:

$$AV = \frac{V \times N \times 56.1}{W}$$

Where:

V: Volume of KOH used during titration (mL)

N: Normality of KOH (typically 0.1 N)

W: Weight of oil sample (g)

56.1: Equivalent weight of oleic acid (for Acid Value)

I.2.3.1.3 Refractive index

It measures the degree of refraction of light as it passes from air through oil at a specific temperature. The refractive index is estimated at 20°C in the case of oils, and at 40°C in the case of solid fats. The refractive index is determined practically using a refractometer (JORA, 2011)

I.2.3.1.4 Saponification value

It is defined as the number of milligrams of potassium hydroxide required to saponify one gram of oil. This indicates the average weight of fatty acids present in the oil. It has been found that the higher the proportion of short-chain fatty acids in the oil, the higher its saponification number. This is due to the increased number of short-chain fatty acid molecules linked to glycerol to form the triglycerides of the oil. However, in the case of long-chain fatty acids, the saponification number decreases. The saponification number is calculated using the relationship:

$$I_s = \frac{(V_0 - V_1) \times c \times 56.1}{m}$$

Where:

V₀: is the volume, in milliliters, of hydrochloric acid, used for the blank test;

V₁: is the volume, in milliliters, of hydrochloric acid, used for the determination;

c: is the exact concentration of hydrochloric acid;

m: is the mass, in grams, of the test sample (**JORA, 2011**).

I.2.3.1.5 Iodine value

It is the number of grams of iodine absorbed by 100 grams of oil under specific conditions. The iodine number indicates the number of unsaturated bonds in the oil, meaning it expresses the degree of saturation of the oil. The iodine number decreases in oils with a high percentage of saturated fatty acids and a low percentage of unsaturated fatty acids. Conversely, the iodine number increases in oils with a high percentage of unsaturated fatty acids. It is clear that by estimating the iodine number, adulteration of vegetable oils can be identified. The iodine number is calculated by the relationship

$$I_2 = \frac{(V_b - V_s) \times N \times 12.69}{W}$$

Where:

V_b: volume of sodium thiosulfate used for the blank (mL)

V_s: Volume of sodium thiosulfate used for the sample (mL)

N: Normality of sodium thiosulfate

W: Weight of the sample in grams (**JORA, 2011**).

I.2.3.1.6 Moisture content

The oil sample is heated at 105°C until all moisture evaporates. The weight difference before and after drying is used to calculate the moisture percentage

$$\text{Moisture content(\%)} = \frac{W1 - W2}{W1} \times 100$$

Where:

W1 = Initial weight of the sample before drying (g)

W2 = Final weight of the sample after drying (g) (**JORA, 2011**).

I.2.3.1.7 Peroxide Value

The Peroxide Value (PV) is defined as the amount of peroxides and hydroperoxides formed in fats and oils during the initial stages of oxidation. It is expressed in milliequivalents of active oxygen per kilogram of oil (meq O₂/kg) and is used as an indicator of the oxidative rancidity and freshness of the oil.

$$PV = \frac{N \times (V1 - V0) \times 1000}{m}$$

Where:

PV: Peroxide value (meq O₂/kg)

V1: Volume of sodium thiosulfate used for the sample titration (in mL)

V0: Volume of sodium thiosulfate used for the blank (in mL)

N: Normality of sodium thiosulfate solution (mol/L)

m: Mass of the oil sample (in grams).

I.2.3.2 Composition of antioxidant compounds

The GC-MS method:

The GC-MS method (Gas Chromatography coupled with Mass Spectrometry) is a powerful analytical technique used to identify and quantify volatile or semi-volatile compounds present in a sample.

I.2.3.3 Composition of fatty acids

The HPLC method:

HPLC (High-Performance Liquid Chromatography, or HPLC in French) is an analytical technique used to separate, identify, and quantify compounds present in a mixture.

Basic Principles of HPLC :

1. Mobile Phase: A solvent (or mixture of solvents) transports the solution through a column
2. Station Phase: A solid (consisting of a resin or modified silica) is deposited on the inside of the column on a layer of eluent components that are chemically different from each other.
3. Enchantelle Injection: A small amount of enchantelle is injected into the mobile phase flow.
4. Separation: Each component of the mixture migrates at a different rate, interacting with the stationary phase and mobile phase, allowing for separation.
5. Detection: A detector (UV/Visible only) measures the quantity of each component and the column type.

I.2.4 Characterization of Deglah Beidah powder

I.2.4.1 Preparation of Deglah Beidah powder

(Figure 08) shows the different stages of preparing date powder.



Figure 08: Different stages of preparing Deglah Beidah powder.

I.2.4.1.1 Preliminary Treatment

The dates first undergo manual sorting to separate the infested fruits. They are then manually pitted. The dates are wiped using a damp cloth to remove any dust. Afterward, each date is cut into two pieces (see Appendix) and placed in an oven for drying.

I.2.4.1.2 Drying

Approximately 461 g of date pulp, cut into two pieces, was spread on a tray. Drying was carried out through direct contact of the product with hot air circulating in the oven. The drying process was conducted at a temperature of 75°C for 24 hours. (Hasan et al., 2019)

I.2.4.1.3 Grinding and Sieving

The dried dates obtained were ground into powder using an electric grinder, then hermetically stored in glass jars protected from light.

I.2.4.2 Physicochemical and mineral analysis of Deglah Beidah powder

The purpose of these analyses is to control the quality of the raw materials intended for the production of biscuits, as well as the quality of the final product obtained.

I.2.4.2.1 Determination of Moisture Content (Yahmi & Tigharghar, 2017)

The moisture content represents the percentage of the water mass contained in 1g of fruit, and it is determined using an oven. The moisture content percentage is given by the following formula:

$$\text{H}_2\text{O}\% = \frac{(\text{P}_{\text{cv}} + \text{P}_{\text{e}}) - \text{P}_{\text{cf}}}{\text{P}_{\text{e}}} \times 100$$

Were:

PCV: empty capsule weight.

Pe: test sample.

PCf: final capsule weight.

I.2.4.2.2 Determination of ashes content

This method consists of destroying the organic matter through the dry ashes technique or calcination, which involves burning the sample in a muffle furnace and collecting the greyish-white mineral residue after incineration of 5g of dates at 550°C until complete combustion of the organic matter.

The ashes content is determined relative to the dry matter according to the following formula:

$$\text{Ashes content} = \frac{P_{cf} - P_{cv}}{P_e} \times 100$$

Were :

P_{cf} : Final capsule weight.

P_{cv} : Empty capsule weight.

P_e : Test sample.

I.2.4.2.3 Determination of pH

This method is based on determining, in pH units, the potential difference existing between two electrodes immersed in an aqueous solution of the date sample.

I.2.4.2.4 Determination of protein content

The Kjeldahl method is the reference method for dosage of total nitrogen for the food domain. It consists in performing a complete mineralization of molecules organic, transforming nitrogen present into ammonia which can be dosed by different techniques (**Guillou et al., 1976**).

$$\text{Protein content} = \text{Total content} \times \text{coefficient}$$

I.2.4.2.5 Determination of total carbohydrate content (Bertrand Method)

The principle of the assay:

An excess of alkaline copper liquor is allowed to react with the sugars under precisely controlled conditions. The cuprous oxide formed is separated and then treated with a sulfuric liquor of ferric sulfate.

II.2.4.2.6 Determination of lipid content (Soxhlet Method)

Fat are organic substances that can be extracted from fruits and plants using non polar organic solvents with the aid of a Soxhlet apparatus. The fat content is calculated as follows:

$$Mg = \frac{P_2 - P_1}{P_3} \times 100$$

Were :

P₁ : Weight of the empty balloon.

P₂ : Weight of the balloon with the date fruit.

P₃ : Weight of the test sample.

II.2.4.2.7 Mineral analysis

The mineral elements (Calcium, Magnesium, Iron, Potassium, Zinc and Lead) were measured separately using atomic absorption spectrophotometer (**Bouras et al., 2025**).

Part II: Formulation and characterization of madeleines

II.1 Formulation of madeleines

All the different types of madeleines follow the manufacturing diagram below (figure 09).

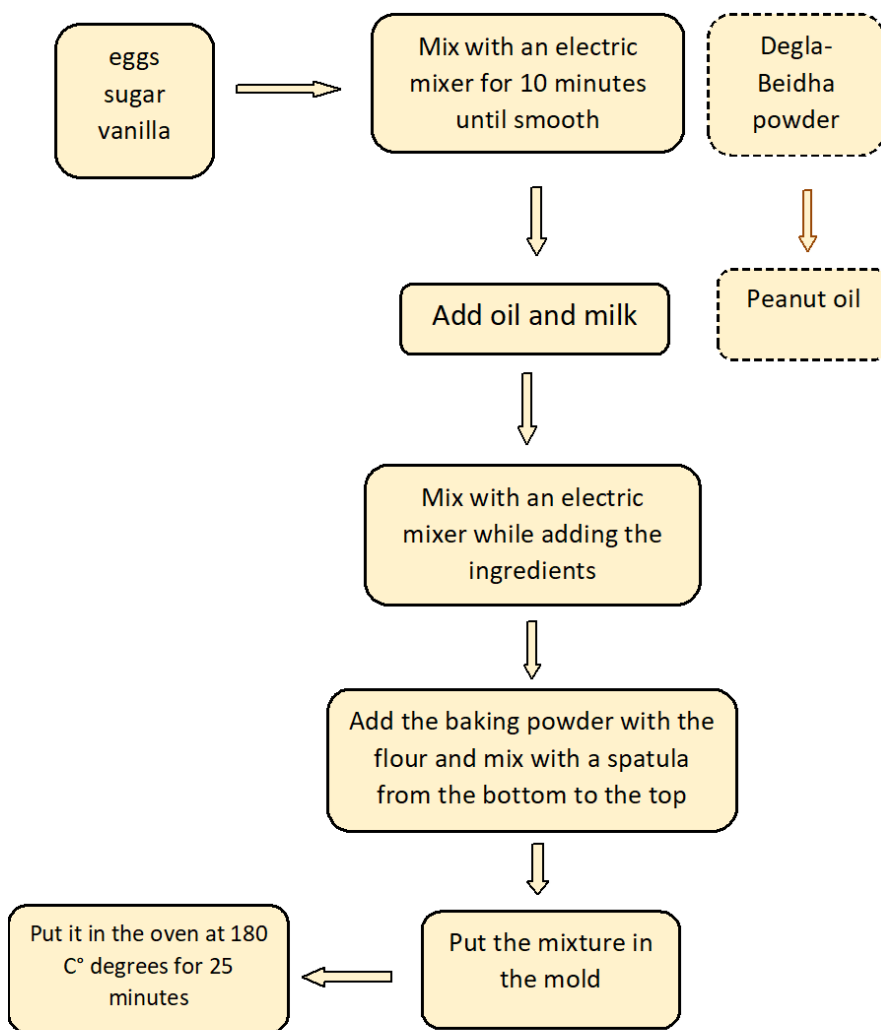


Figure 09: Manufacturing diagram of madeleines.

The method for preparing madeleines includes several steps:

- Add the eggs and a little vanilla to the sugar and beat for 10 minutes at high speed;

- Gradually add the oil and milk to the mixture;
- Add the yeast to the flour, then gradually and gently combine these ingredients;
- Dry the mixture using a plastic spoon;
- Pour the mixture into a mold and bake immediately in a preheated oven at 180°C for 25 minutes.

The preparation is done in different proportions, combining the two alternatives in different ways:

- ✓ **F1:** Traditional madeleines containing hydrogenated oil and refined sugar(control)
- ✓ **F2P:** hydrogenated oil was replace with peanut oil, while refined sugar was retained.
- ✓ **F3PD:** Both hydrogenated oil and refined sugar were simultaneously replaced with peanut oil and deglah beidha powder, respectively (fully modified healthy formulation).
- ✓ **F4D:** refined sugar was replace with deglah beidha powder, while hydrogenated oil was retained.

II.2 Characterization of madeleines

II.2.1 Physicochemical analysis of madeleines

pH: The samples were characterized for pH according to AACC Method No. 02-52 (2000).

Using a pH meter with a BlueLine 11 combination electrode (**Schott Geräte GmbH, Mainz, Germany**)

A. Principle

the pH is determined in pH units by the potential difference between two electrodes located in a ground sample solution.

B. Procedure

- Weigh 10 g of ground sample;
- Add 25 ml of distilled water to the sample;
- Stir for half an hour;
- Measure the pH using a pH meter (**Menasra, 2020**).

Determination of Cooking Loss

Cooking loss was measured by dividing the difference in weight before and after baking by the weight of the dough before baking (**Ameur and Lemmadi, 2019**)

Cooking loss (%)

$$= \frac{(\text{weight of dough before cooking} - \text{weight of madeleines after cooking})}{\text{weight of dough before cooking}} \times 100$$

Determination of the Specific Volume of Madeleines

Specific volume is one of the most important physical properties of madeleine-type cakes; the higher the volume, the more appreciated the product.

A. Principle

The specific volume of cakes is determined using the method described by **Benatallah (2009)**. The measurement is performed indirectly by displacing small specific particles (Semsem) of known specific volume in a container where the final cake is placed.

B. Procedure

Take a container with a volume larger than that of the cakes and fill it to the brim with Semsem of known Vsp (0.71 cm³/g). For the measurement itself, half empty the container of its Semsem content, place the cake in it, and cover the sample with the remaining Semsem. After leveling the surface of the measuring container, collect the excess Semsem. Its volume corresponds to that of the cakes (Figure 10).

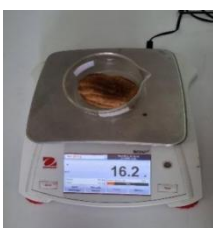
			
Weigh the madeleine	Place the madeleine and cover the sample with the remaining spherical grains.	Leveling the surface of the container	Weigh the excess spherical grains and calculate the specific volume (cm ³ /g)

Figure 10: Measurements of the specific volumes of the 4 madeleine formulas using the grain displacement method

II.2.2 Sensory analysis of madeleines

It is the examination of the sensory characteristics of a product using the senses (**ISO 5492**). It allows the study of the sensory characteristics of a product produced using humans as a "measuring instrument" using their five senses: smell, taste, sight, hearing, and touch (**Belkacemi and Rahmani, 2019**).

- **Objective**

The objective of the analysis is to identify sensory descriptions and determine naive consumer preferences regarding madeleines. This analysis is conducted by 30 consumers from various categories. They are professors and students from the SNV Faculty, which benefited from the sensory analysis.

- **Principle**

The principle consists of presenting a subject with a sample of madeleines for which they must specify certain sensory characteristics evaluated through visual observations and tasting. Each taster gives their judgment separately from the others and provides a score on a tasting sheet. The characterization focuses on color, texture (crumbly, soft, grainy, light, and firm), appearance, odor, taste/aroma, and overall appreciation. Finally, the taster will rank the samples based on the overall acceptability (odor, taste/aroma, and texture) of the product. These characteristics are evaluated on a scale of 1 to 9.

- **Sensory analysis procedures**

The panelists were presented with four different series of madeleine samples, each corresponding to a specific formulation:

Series 1: F1: Control formulation (hydrogenated oil + refined sugar)

Series 2: F2P: Substitution of hydrogenated oil with peanut oil

Series 3: F3PD: Simultaneous substitution of hydrogenated oil with peanut oil and refined sugar with deglah beidha powder

Series 4: F4D: Substitution of refined sugar with deglah beidha powder only

The sensory attributes of these samples were evaluated by the panelists. At the end of the evaluation, each taster was asked to rank the four madeleine samples according to their personal preference. The samples were provided in a blind test format, without disclosing their formulations to the panelists. Clear instructions were given regarding the evaluation process and how to properly complete the response sheets, as illustrated in **(Figure 11)**.

Sensory Analysis Sheet				
First and last name :		Age : years		Gender M/F
1- Please examine and taste each set of madeleine samples, then rank them by answering the following questionnaires :				
1 ➔ 9				
	F1	F2	F3	F4
External Appearance				
Color				
Odor				
Texture Crumbly Soft Grainy Light Firm				
Taste/Aroma				
Overall Appearance				

Figure 11: Sensory sheet for tasters.

II.2.3 Image analysis of the crumb of madeleines

For image analysis, we used Image J software (Fiji v1.54g USA). for image processing of the crumb of the different madeleine formulations. This software allowed us to analyze particles and get an idea of different parameters such as the number and surface area of the alveoli.

II.2.4 Statistical analysis

All experiments and analyses were carried out in triplicates and the obtained data were expressed as means $\pm$ standard deviation. Statistical analysis was performed using Minitab 19 software (Minitab Inc., State College, PA, USA) using Tukey's t-test (ANOVA) with $\alpha = 95\%$.

Chapter 2

Results and discussion

Our goal was to create a new formulation of the madeleine using peanut oil and Deglah Beidha powder. This biscuit is characterized by its nutritional value (no refined oils/no hydrogenated fats/no industrial sugars). We divided the results and their discussion into two main parts.

Part I: Characteristics of the raw material used

I.1 Characteristics of peanut oil

I.1.1 Physicochemical properties of peanut oil

Table 07 presents the main physicochemical parameters of peanut oil.

Table 07: Physicochemical analysis of peanut oil.

Parameters	Results
pH value	6.4 ±0.15
Degree of acidity (%)	0.52±0.01
Refractive index	1.46±0.02
Saponification value (mg KOH/g)	195±0.02
Iodine value	92±0.02
Moisture content (%)	0.18±0.01
Peroxide value (meq O₂/kg)	4.2±0.01

The physicochemical analysis of peanut oil revealed several important parameters that highlight its potential for food processing applications, particularly in the formulation of healthier bakery products.

pH value (6.4 ± 0.15): The oil's pH indicates a slightly acidic nature, which is typical for vegetable oils and contributes to their microbial stability. A pH around this value helps minimize bacterial growth (**Chaiyasit et al, 2007**), which is favorable for food safety and shelf life.

Degree of Acidity (0.52 ± 0.01%): This low acidity is an indicator of good oil quality and freshness, as elevated acidity often signals lipid hydrolysis or degradation (**Codex Alimentarius 2019**).

Refractive Index (1.4666 ± 0.02): The refractive index is within the standard range for edible oils (between 1.460 and 1.470), which suggests that the oil is pure and has not undergone oxidation or adulteration (**Codex Alimentarius, 2019**).

The saponification value of the studied peanut oil was ($195 \text{ mg KOH/g} \pm 0.02$), which falls within the typical range for this oil (185–195 mg KOH/g). This indicates good quality and a predominance of medium-chain fatty acid (**Codex Alimentarius, 2019**).

Iodine Value (92 ± 0.02), suggesting the oil is relatively stable against oxidation, yet still contains beneficial unsaturated fats. This supports the nutritional quality of the oil (**Codex Alimentarius, 2019**).

Peroxide Value (4.2 ± 0.01), which is considered low and within the acceptable limit ($<5 \text{ meq O}_2/\text{kg}$) according to **Codex Alimentarius (2019)**. This indicates that the oil has not undergone excessive oxidation and maintains good quality. A low peroxide value is an indicator of proper storage conditions that help preserve the oil's stability and resistance to primary oxidation (**Aladedunye and Przybylski, 2013**).

I.1.2 Antioxidant compounds of peanut oil

In this study, we can identify 27 antioxidant compounds in peanut oil (table 08, figure 12). Most antioxidant compounds are flavonoids (14), phenols (4), phenolic acids (4) and other compounds.

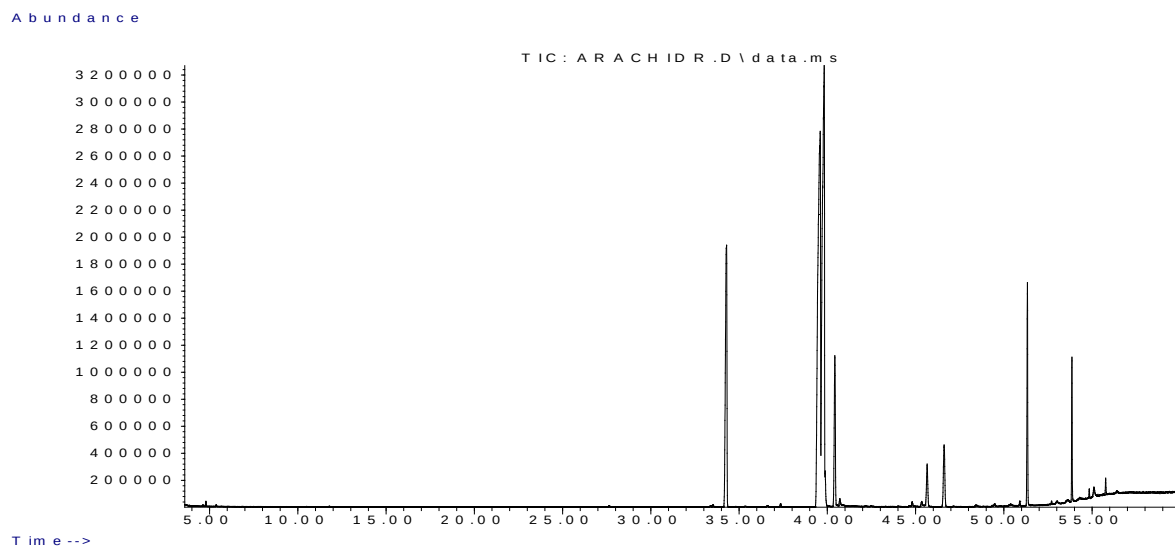


Figure 12: Chromatogram of antioxidant compounds in peanut oil.

I.1.3 Fatty acids profile of peanut oil

The detailed fatty acid composition of peanut oil is presented in table 08.

Table 08: Fatty acids composition of peanut oil.

Name of the compound	MW	Formula	Composition (%)	Peanut Oil Codex
Methyl myristate	242	C ₁₅ H ₃₀ O ₂	0.04	
Palmitic acid	256	C ₁₆ H ₃₂ O ₂	0.01	8.0-14.0
Palmitoleate Methyl	268	C ₁₇ H ₃₂ O ₂	0.10	ND-0.1
Palmitic acid methyl ester	270	C ₁₇ H ₃₄ O ₂	13.75	ND-0.1
Methyl margarate	284	C ₁₈ H ₃₆ O ₂	0.11	1.0-4.5
Linoleic acid methyl ester	294	C ₁₉ H ₃₄ O ₂	33.34	12.0-43.0
Oleic acid methyl ester	296	C ₁₉ H ₃₆ O ₂	33.45	35.0-69
Stearic acid methyl ester	298	C ₁₉ H ₃₈ O ₂	5.77	1.0-4.5
Eicosenoic acid methyl ester	324	C ₂₁ H ₄₀ O ₂	1.77	0.7-1.7
Arachidic acid methyl ester	326	C ₂₁ H ₄₂ O ₂	3.05	1.0-2.0
Behenic acid methyl ester	354	C ₂₃ H ₄₆ O ₂	5.20	1.5-4.5
Methyl tricosanoate	368	C ₂₄ H ₄₈ O ₂	0.13	
Methyl lignocerate	382	C ₂₅ H ₅₀ O ₂	2.89	
Methyl hexacosanoate	410	C ₂₇ H ₅₄ O ₂	0.41	

The table 09 reveals that the studied oil exhibits a diverse profile of saturated and unsaturated fatty acids, reflecting its richness in compounds with notable nutritional and functional properties. The oil is characterized by a high content of unsaturated fatty acids, particularly oleic acid and linoleic acid, which accounted for 33.45% and 33.34%, respectively. This balance between the two acids is considered a positive indicator in terms of oxidative stability and health benefits.

Oleic acid (Omega-9) is known for its role in lowering harmful LDL cholesterol levels (**Lopez-Huertas, 2010**) while linoleic acid (Omega-6) is an essential dietary component, although its intake should be balanced with Omega-3 consumption (**Ramsden et al., 2013**).

The oleic acid content in the studied sample falls within the reference range established by the Codex (35–69%), although it tends toward the lower limit. This may suggest genetic variability in the peanut cultivar used or the influence of climatic and agricultural conditions on the composition (**Zhang et al., 2023**). Conversely, the linoleic acid content of 33.34% lies well within the acceptable range (12–43%), further supporting the oil's quality in terms of fatty acid balance.

Regarding saturated fatty acids. The palmitic acid content in the sample was 0.01%, which is significantly lower than the typical reference range (8.0–14.0%). This unusually low level may be due to genetic differences in the peanut cultivar, partial refining of the oil or analytical variability related to GC-MS or GC-FID sensitivity. While palmitic acid is generally associated with increased LDL cholesterol when present in high amounts, its very low presence here is considered beneficial from a nutritional perspective (**German and Dillard, 2004**).

The stearic acid content in the sample was 5.77%, which slightly exceeds the typical reference range (1.0–4.5%). However, research shows that stearic acid has a neutral effect on cholesterol levels and is not considered harmful to cardiovascular health (**Hunter et al., 2010**).

I.2 Characteristics of Deglah Beidah powder

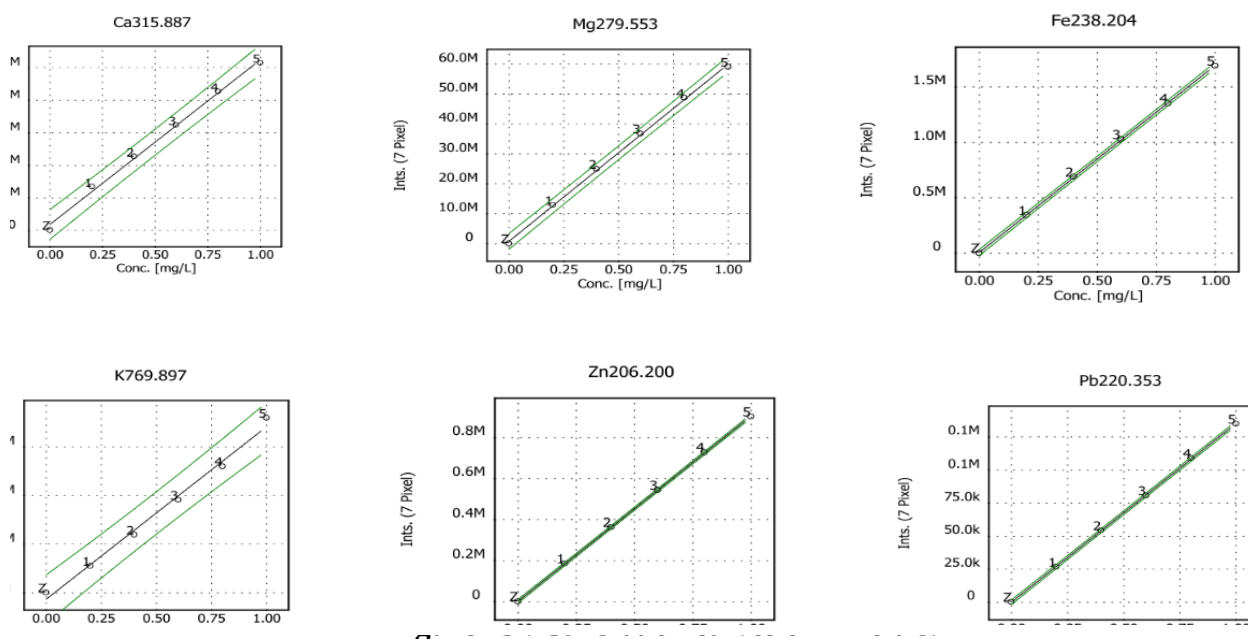
I.2.1 Physicochemical and mineral analysis of Deglah Beidah powder

The analyzed physicochemical parameters and detected minerals are presented in table 09 and figure 13.

Table 09: Physicochemical and mineral analysis of Deglah Beidah powder (per 100g).

Parameters	Results
<i>Physicochemical analysis</i>	
pH	5.56± 0.15
Carbohydrates (g)	75.21 ±0.02
Fat (g)	0.67 ±0.02
Proteins (g)	1.75±0.01
Moisture content (%)	7.15 ± 0.01
<i>Mineral analysis</i>	
Ashes (g)	1.72±0.02
Calcium	0.07
Magnesium	0.032
Iron	0.62 ×10 ⁻⁵
Potassium	0.97×10 ⁻⁵
Zinc	0.45 ×10 ⁻⁵
Lead	4×10 ⁻⁵

The illustrated figure shows the calibration curves of the measured minerals.



Comprehensive interpretation of the physicochemical and mineral analysis of Deglah Beidha date powder, conducted to assess its suitability as a healthy substitute for white sugar in Madeleine production.

The pH value of DB powder was 5.56 ± 0.15 , indicating a mildly acidic environment that may help inhibit the growth of pathogenic microorganisms, thereby enhancing the microbiological stability of the product, supporting their application in food preservation (**Fathi, 2021**).

The carbohydrate content was significantly high at 75.21 ± 0.02 g, confirming the DB powder as a rich source of natural sugars such as sucrose, fructose, and glucose, which are ideal alternatives to refined sugars in functional food products (**Al-Farsi and Lee 2019**).

The fat content was 0.67 ± 0.02 %, The results showed that DB powder contained a relatively low fat content of 0.67%, This low percentage reflects an important nutritional advantage, especially when DB powder is used as an alternative ingredient in healthy products. Its low fat content makes it suitable for low-fat diets and contributes to a lower overall calorie intake compared to using refined fats or processed sugars, sometimes accompanied by added fats.

Protein content was 0.28 ± 0.01 g, while relatively low; this quantity still contributes to the protein profile of madeleines. That although dates are not high-protein foods, they contribute beneficially to the amino acid composition of food products (**Al-Farsi and Lee, 2008**).

The moisture content was 7.15 ± 0.01 %, a desirable trait for powdered products as extends shelf life, prevent microbial growth (**Bakshi et al., 2023**). DB powder demonstrates strong potential as a functional ingredient in health-oriented bakery formulations, with its high carbohydrate content, acceptable fat profile.

Lastly, Ashes content reached 1.72 ± 0.02 g, suggesting a rich mineral profile. Specific mineral analysis revealed the presence of calcium (0.07g), magnesium (0.032g), iron (6.2×10^{-5} g), potassium (9.7×10^{-5} g), and zinc (4.5×10^{-5} g), with lead levels (4×10^{-5} g) below international safety limits. The mineral profile aligns with the *Codex Alimentarius* standards (**FAO/WHO, 2021**), affirming the product's safety and nutritional quality.

Part II: Characteristics of the different Madeleine formulations

II.1 Physicochemical properties of madeleines

The table below presents some essential parameters of madeleines.

Table 10: Physicochemical properties of formulated Madeleines.

Parameters	F1(control)	F2P	F3PD	F4D
pH	6.82±0.00 ^a	6.72±0.04 ^a	6.77±0.01 ^{ab}	6.80±0.02 ^b
Specific volume (cm ³ /g)	8.93±0.03 ^a	10.72±0.01 ^b	11.88±0.05 ^c	10.4±0.07 ^d
Cooking loss (%)	6.33±0.25 ^a	8.95±0.05 ^b	9.87±0.11 ^c	7.51±0.14 ^d

F1: madeleine control, F2P: madeleine with peanut oil only, F3PD: madeleine with peanut oil and Deglah Beidah powder and F4D: madeleine with Deglah Beidah powder only. a, b, c and d: letters indicate the significant difference of means in the same row (P <0.05) (ANOVA test: Tukey test).

Statistical analysis showed that there was a significant difference (P <0.05) in specific volume and cooking loss. Regarding pH, we did not observe a significant difference between F1, F2P and F3PD.

The table shows that the pH values range between 6.72 and 6.82, indicating that all formulations fall within a near-neutral range. This is important in terms of both palatability and microbiological safety. The F2P formulation recorded the lowest pH value (6.72), while the control formulation F1 exhibited the highest (6.82).

The slight decrease in pH observed in F2P and F3PD may be attributed to the presence of natural ingredients such as peanut oil and date powder, which contain organic compounds (e.g., organic acids and Phenolic) that influence the acid-base balance of the product (**Liu, 2003**). These minor variations in pH remain within the acceptable range and do not negatively impact the overall quality of the product.

The results showed a clear variation in the specific volume values among the four formulations, reflecting the influence of the type of ingredients used on the aerated structure of the product. Formulation F3PD, which contained a combination of peanut oil and white date powder, recorded the highest specific volume at 11.88 cm³/g, followed by formulation F2P (10.72 cm³/g), which included peanut oil and white sugar. Formulation F4D (10.40 cm³/g), containing only white date powder with regular oil, ranked third, while the control formulation F1, which lacked both white date powder and peanut oil, recorded the lowest specific volume (8.93 cm³/g).

These results indicate that formulation F3PD, which combined two natural ingredients known for their lightness and nutritional value (peanut oil and white date powder), allowed the dough to expand and aerate more effectively during baking, which positively influenced the specific volume. Formulation F2P, which relied solely on peanut oil without benefiting from the natural sugars present in date powder, achieved a good specific volume but lower than F3PD, suggesting the additional role that white date powder plays in enhancing dough structure. On the other hand, F4D, which contained only white date powder with conventional oil, ranked third, indicating that substituting regular oil with peanut oil results in a notable difference in aeration.

The control formulation F1, which did not include any of the studied natural ingredients, showed the lowest specific volume, suggesting a denser texture and less aerated structure, which could negatively affect the sensory attributes of the product. Therefore, the combination of peanut oil and white date powder appears to be a promising approach for improving the physical structure of baked goods and enhancing their palatability without the need for artificial additives. Specific volume serves as a strong indicator supporting the selection of F3PD as the most structurally favorable and aerated formulation among those tested.

The highest cooking loss was observed in formulation F3PD (9.87%), while the lowest was recorded in F1 (6.33%). Date powder contains sugars and fibers that do not retain moisture as effectively as conventional saturated fats, which accelerates moisture loss during baking. Additionally, peanut oil contributes less to water retention compared to butter or hydrogenated oils (Sudha *et al.*, 2007).

II.2 Sensory properties of madeleines

The figure 14 illustrates the different formulations of madeleines as finished products before tasting.

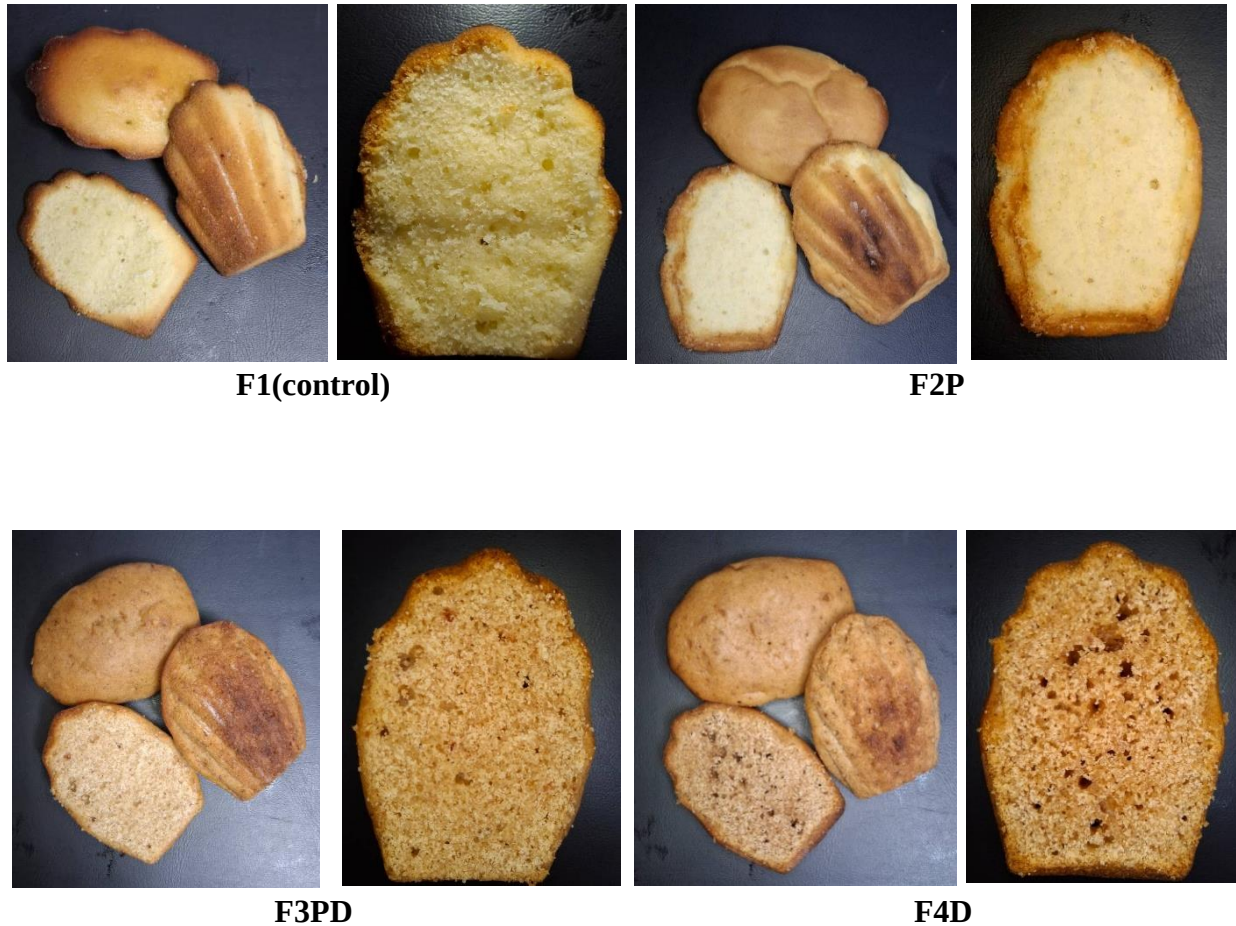


Figure 14: Finished Madeleines before tasting.

Following the tasting of the different formulations of madeleines with 40 volunteers (teachers + students + staff), we collected and analyzed the results which are presented in table 11. The score used was 0 to 9.

Table 11: Sensory parameters of finished madeleines.

Parameters	F1(control)	F2P	F3PD	F4D
Appearance	5.62±2.27 ^a	5.3±1.88 ^b	7.75±1.53 ^c	6.95±1.85 ^d
Texture				
Soft	5.81±2.17 ^a	6.51 ±1.75 ^a	8.45 ±0.76 ^a	7.97 ±1.34 ^a
Crumbly	3.56± 2.06 ^a	7.0± 1.87 ^{ab}	8.02 ±1.14 ^b	7.75 ±1.32 ^{ab}
Grainy	3.43 ±2.36 ^a	5.13± 1.84 ^a	7.59± 1.7 ^a	6.91 ±1.81 ^a
Light	3.05± 2.36 ^a	6.27± 1.71 ^{ab}	8 ± 1.33 ^b	7.86 ±1.2 ^b
Firm	6.97 ±2.4 ^a	3.81± 1.68 ^{ab}	1.67 ±0.49 ^b	3.05± 1.74 ^{ab}
Exterior Color	5.6±2.31 ^a	5.65±2.02 ^a	7.52±1.69 ^a	6.7±2.01 ^a
Odor	6.07±2.48 ^a	4.27±1.97 ^a	6.55±1.58 ^a	6.65±1.88 ^a
Taste	5.47±0.53 ^{ab}	4.12±1.06 ^a	7.36±0.67 ^c	6.57±0.37 ^{cb}
Overall acceptance	5.77±0.5 ^{ab}	4.7±0.9 ^b	6.97±0.3 ^a	7.05±0.5 ^a

F1: madeleine control, **F2P:** madeleine with peanut oil only, **F3PD:** madeleine with peanut oil and Deglah Beidah powder and **F4D:** madeleine with Deglah Beidah powder only. a, b, c and d: letters indicate the significant difference of means in the same row (P <0.05) (ANOVA test: Tukey test).

Based on statistical analyses, it appears that the different formulations of madeleines appear to have a significant difference (P <0.05) mainly in appearance, some textural parameters and in taste.

▪ Formulation with Deglah Beidah powder only (F4D)

The F4D formulation achieved the second-highest score in appearance (6.95±1.85), following F3PD. This reflects the visually pleasing effect of white DB powder on the madeleine's appearance, particularly in terms of color and surface puffiness. This result can be attributed to the natural thermal reactions of the monosaccharides in dried dates, which help develop an attractive and uniform color (Siddiq *et al.*, 2010).

The color score reached 6.7±2.01, an excellent result confirming that white DB powder can impart an attractive and desirable hue without artificial coloring agents. This outcome is largely due to the natural browning reactions of sugars during baking.

The formulation received a high score in odor (6.65±1.88), indicating that white DB powder contributes not only to nutritional value but also enhances the aromatic profile of baked goods.

Flavonoids and phenolic compounds in dates exhibit distinctive aromatic properties when heated (Vinson et al., 2005).

F4D achieved a high taste score (6.57 ± 1.37), ranking second after F3PD. This can be attributed to the natural sweetness of fructose and glucose in DB, which substitute for refined sugar while offering a rich and pleasant flavor. Deglah beidha provide both sweetness and a unique, desirable taste (Al-Shahib and Marshall, 2003). This formulation recorded the highest overall appreciation score (7.05 ± 1.50), indicating that consumers generally preferred this model due to the well-balanced integration of taste, texture, and appearance.

▪ Formulation with peanut oil and Deglah Beidah powder (F3PD)

F3PD scored the highest in appearance (7.25 ± 1.33), reflecting an attractive visual profile. The combination of peanut oil and DB powder contributed to an enhanced color tone, smooth texture, and ideal rise during baking.

The color rating (6.8 ± 1.70) was the highest among all samples, indicating consumer preference for the golden-brown appearance achieved by reaction between amino acids and natural sugars present in both ingredients. F3PD received the highest odor rating (7.00 ± 1.75). This outcome is due to the aromatic volatiles produced during the thermal degradation of fatty acids in peanut oil and caramelization of natural sugars in date powder (Vinson et al., 2005).

F3PD achieved a high overall appreciation (6.85 ± 1.66), confirming that this formulation is the most preferred. It delivered on all sensory parameters with strong consistency. The synergy between peanut oil and white DB powder in F3PD created a balanced, flavorful, and healthy alternative to traditional madeleines. This formulation is well suited for consumers seeking both nutrition and indulgence.

▪ Formulation with peanut oil only (F2P)

F2P had a moderate appearance score (6.00 ± 1.67), indicating a less appealing visual profile. The color rating (5.90 ± 1.75) was among the lowest, supporting the visual impression of a lighter. Odor score (6.20 ± 2.07) was moderate. Although peanut oil contributes to a pleasant nutty aroma,

the absence of aromatic sugar degradation limited olfactory richness. F2P received the lowest overall appreciation score (5.55 ± 1.90), reflecting the impact of natural sugars on consumer acceptability. While peanut oil improved softness and added a mild nutty flavor, the lack of a sugar substitute significantly reduced overall product appeal. This sample emphasizes the necessity of both fat and sugar alternatives for optimal sensory performance.

▪ Formulation control (F1)

F1 scored (6.30 ± 1.98), due to standard baking reactions using hydrogenated fats and refined sugars. Color received a reasonable score (6.30 ± 1.83), consistent with expected browning from sugar and fat interaction. Odor was moderate (6.35 ± 1.84), with no distinct aromatic enhancements. F1 had an overall appreciation score of (6.30 ± 1.49), serving as a useful baseline for comparison. The F1 confirmed the standard sensory quality of madeleines using conventional ingredients, against which the benefits of F3PD and F4D became evident.

F3PD and F4D outperformed the others in overall appreciation (6.85 ± 1.66 and 6.70 ± 1.63 , respectively), indicating that consumers favored samples containing DB powder, whether alone or in combination. The control sample F1 was rated moderately (6.30 ± 1.49), and F2P came last (5.55 ± 1.90). Among all formulations, F3PD showed superior sensory qualities across every measured criterion. The synergy of peanut oil and white DB powder surpassed the traditional formulation (F1). These results highlight the potential of combining natural, healthful ingredients to develop bakery products with improved sensory properties and nutritional value.

The figure 15 below summarizes the sensory profile of the different formulations of madeleines.

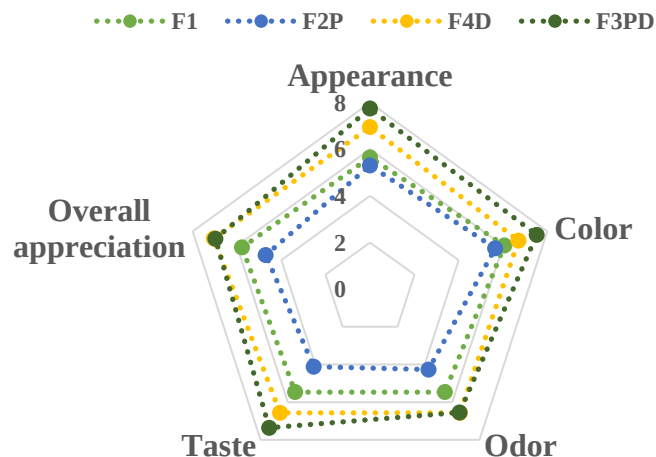


Figure 15: Sensory profile of different formulations of madeleines.

II.3 Textural properties of the crumb of madeleines

The following figure 16 summarizes the sensory evaluation of texture-related attributes for madeleines formulations, highlighting differences in softness, lightness, crumbliness, and graininess.

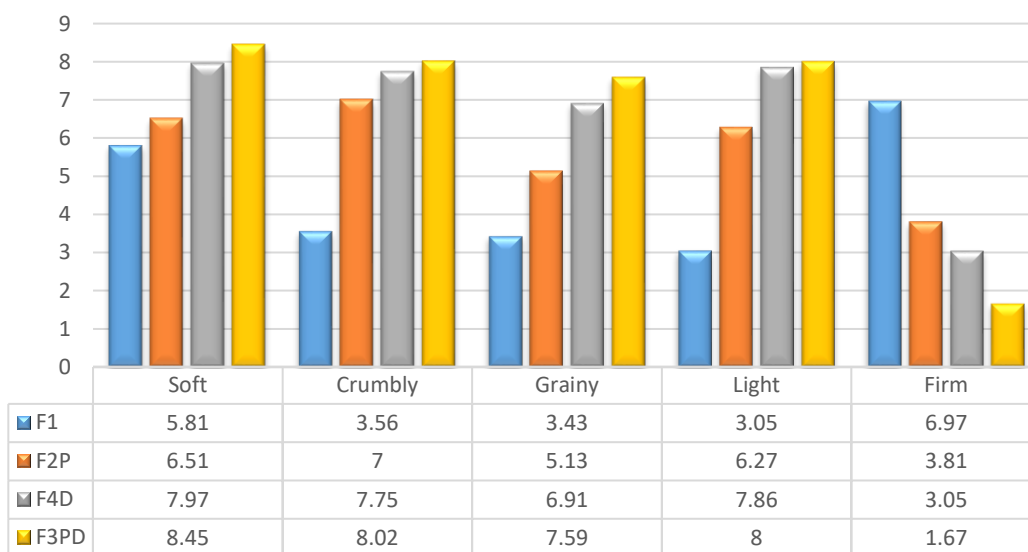


Figure 16: Texture results of F1, F2P, F3PD and F4D.

The figure 16 illustrates the textural evaluation results of different madeleines, which varied in their formulation regarding the type of oil and sweeteners used. These results reveal significant

differences in textural properties, reflecting the impact of the recipe components on the final product structure.

- **Softness**

F3PD achieved the highest score of 8.45, followed by F4D with 7.97, F2P with 6.51, and the madeleine F1 with 5.81. This ranking clearly indicates that the softening effect provided by both peanut oil and DB powder, which is desirable. This effect may be attributed to the monounsaturated fat composition of peanut oil and the naturally moist texture contributed by the DB powder.

- **Crumbly**

F3PD again recorded the highest score (8.02), followed by F4D (7.75), F2P (7.00), and the control sample F1 with the lowest score of 3.56. This improvement can be explained by the structure-enhancing properties of DB powder compared to refined sugars, and the physical properties of peanut oil promoting crumbliness.

- **Grainy**

The sample F3PD (which contains peanut oil and DB powder) received the highest score (7.59), indicating that it was the lightest and most aerated. In contrast, the F1 sample (made with hydrogenated oil and refined sugar) scored the lowest (3.43), reflecting a denser and less aerated structure.

- **Lightness**

F3PD (8.00) and F4D (7.86) were the best. This result suggests that DB powder contributes to better aeration and a spongier texture, even in the absence of refined sugar. The F1 sample again scored the lowest (3.05), highlighting the poor texture quality associated with hydrogenated and refined components.

- **Firmness**

which is preferably moderate, the highest firmness was found in F1 (6.97), while the lowest was recorded in F3PD (1.67). These results indicate that hydrogenated oils lead to a tougher structure, which may be less acceptable to consumers. In contrast, products made with peanut oil and DB powder show greater softness and ease of chewing, which is typically preferred by consumers.

The F3PD formulation, representing the proposed healthy alternative, showed superior performance in key texture attributes such as softness, crumbliness, lightness, and uniformity. In contrast, the control F1 sample, made with hydrogenated and refined ingredients, displayed inferior texture and increased firmness. This highlights that using natural ingredients like peanut oil and DB powder not only improves nutritional value but also enhances sensory quality, making it an ideal healthy choice for consumers.

The figure 17 summarizes the sensory profile at the texture level of different madeleines.

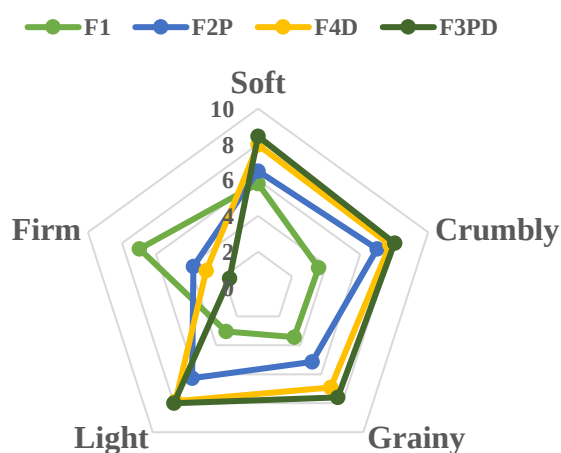


Figure 17: Texture profile of madeleines (F1 F2P F3PD and F4D).

The characteristics of the alveoli of the crumb of the different formulations of madeleines are obtained from the image analysis (figure 18) and are presented in table 13.

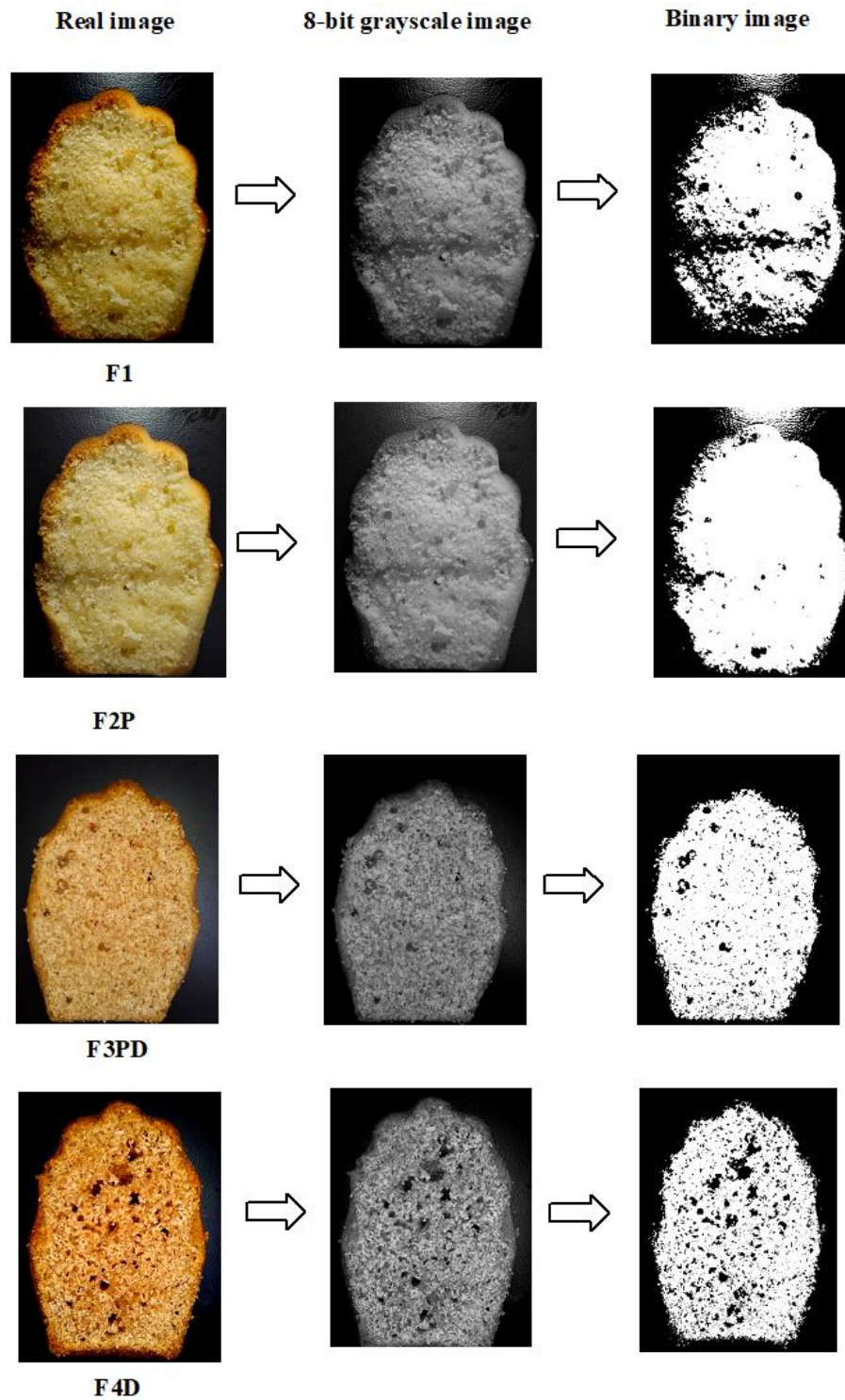


Figure 18: Images of the different formulations of madeleines after processing with the Image J software.

Table 12: Results of the analysis of the crumb images of different madeleines formulations.

Parameters	F1	F2P	F3PD	F4D
Number of alveoli	310.33±20.20	29.33±2.30	63.66±13.27	186.33±9.45
Average area	2.36±0.02	2.3±0.08	2.24±0.02	2.26±0.01
Percentage of alveoli area	76.66±5.77	14±5.19	16.66±2.88	46.66±1.15
Circularity	0.97±1.36	0.96±0.01	0.97±0.005	0.85±0.10

F1: madeleine control, F2P: madeleine with peanut oil only, F3PD: madeleine with peanut oil and Deglah Beidah powder and F4D: madeleine with Deglah Beidah powder only.

According to table 13, the highest alveolar count was recorded in sample F1 (310.33±20.20), indicating that the use of hydrogenated oils and artificial sugars significantly enhances alveolar formation. this is not necessarily a positive indicator, as this type of ventilation may be due to a high content of hydrogenated fatty substances, which contribute to the formation of an in homogeneous structure.

The highest number of vesicles was recorded in F1 (310.33), followed by F2 (233.20), then F4 (186.33), and the lowest in F3 (65.66), indicating a direct relationship between the number of vesicles and the use of synthetic components. The highest void percentage was recorded in F1 (76.66%), followed by F4 (46.66%), then F2 (45.19%), and the lowest in F3 (16.66%), indicating a direct relationship between the void percentage and the use of hydrogenated oils and synthetic sugar.

The average surface area of the alveoli represents the proportion of cells in the measurement area, i.e., the relative porosity (void fraction) (Švec and Hrušková, 2004; Boussis and Ghesmoune, 2019).

The porosity of the cake texture was determined by the air trapped during mixing, the evaporation of water, and the CO₂ produced by the yeast. This is because baking powder has a dual action: it releases air bubbles during mixing and allows the production of carbon dioxide and gas cells by heating throughout the baking process. During heating, CO₂ and water vapor are produced, and the initial air bubbles in the dough act as a nucleus for the formation of pores in the final crumb of the cakes. As the initial bubbles form, the final cake will have a more porous

and uniform texture (**Movahhed et al., 2016**).

Circularity provides information about the shape of the alveoli; according to the results in table 13, all madeleines are characterized by round alveoli with circularity values varying between 0.85 and 0.96.

Conclusion

Conclusion

This study aimed to develop a healthy madeleine product using peanut oil and Deglah Beidha powder as an alternative to industrial ingredients that are harmful to health. In our study, we extracted peanut oil using the Soxhlet method and prepared Deglah Beidha powder by oven drying and were ground using an electric blender. To characterize our raw material, we performed physicochemical analyses on the peanut oil and its antioxidant component composition using GCMS and the fatty acid profile using HPLC. In addition, the Deglah Beidha powder underwent further physicochemical and mineral characterization using atomic absorption spectrophotometry. Regarding the madeleine formulation, we manufactured four different formulations based on their peanut oil content and Deglah Beidha powder alone or in combination. The results collected are as follows:

Peanut oil was characterized mainly by an acidity of 0.52 ± 0.01 and pH value 6.4 ± 0.15 , moisture content $0.18 \pm 0.01\%$, peroxide value 4.5 ± 0.01 meqO₂/g and iodine value 92 ± 0.02 . Based on these results, we can say that the extracted oil is of good quality. In addition, it contains 27 identified antioxidant compounds, most of which are flavonoids. Peanut oil is mainly composed of linoleic acid (33.34%) and oleic acid (33.45%) as major fatty acids; This leaves this oil rich in omega-9 and omega-6.

Deglah Beidha powder is characterized by a pH of 5.56 ± 0.15 , carbohydrates 75.21 ± 0.02 g/100g, proteins 1.75 ± 0.01 , and moisture content 7.15 ± 0.01 g/100g. These results show that the powder is rich primarily in natural sugars. Mineral-wise, the powder is rich in calcium and magnesium.

After formulation and manufacturing of the madeleines, physicochemical analysis shows that there is a significant difference ($P < 0.05$) for specific volume and cooking loss. The highest pH value was recorded for formulation F1 (6.82 ± 0.00). Furthermore, based on statistical analysis, it appears that the different madeleine formulations appear to have significant differences ($P < 0.05$), mainly in appearance, some textural parameters, and taste. For overall acceptance, we recorded that the F3PD formulation was rated 6.97/9 by the tasters.

Texturally, after processing the real images with Image J software, we recorded that our formulation, which is incorporated with peanut oil and Deglah Beidha powder, is characterized by: particle number 63.66 ± 13.27 , average area 2.24 ± 0.02 mm, and a percentage of alveoli area 16.66%.

Finally, following the characterization of the raw material and the analyses carried out on the madeleines, we can conclude that the F3PD formulation appears to be dietetic and can replace commercial madeleines, which contain industrial oils and sugars. Looking ahead, this work could be improved by:

- Studying the fiber composition of Deglah Beidha powder and the vitamin composition of peanut oil;
- Studying the shelf life without and with a natural preservative;
- Studying the microstructure of different madeleine formulations.

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Appendix

Appendix N°01: Extraction of Peanut Oil

The oil was extracted from the sample 100g of peanut using a Soxhlet apparatus with a capacity of 500 mL, employing 350 mL of hexane as the solvent due to its high efficiency in dissolving lipids. The sample was placed in the extraction thimble, and the process was carried out over several hours, during which the solvent underwent continuous cycles of evaporation and condensation, allowing the oil to gradually accumulate in the receiving flask.

Upon completion of the extraction, the solvent was separated from the oil using a rotary evaporator (Rotavap). The recovered oil was then poured into small glass vials and left uncovered at room temperature to allow complete evaporation of any remaining hexane residues.



Appendix N°02: Physicochemical analysis of Peanut oil

2.1. pH value

Since oil does not contain water and cannot be tested directly for pH, a simple emulsion is prepared by mixing oil with distilled water. The pH of the aqueous phase is then measured using a calibrated pH meter.

Procedure:

- Weigh 1 mL of oil.
- Add 5 mL of distilled water (5 times the oil volume).
- Mix thoroughly to obtain a simple emulsion .
- Measure the pH of the mixture using a pre-calibrated pH meter.



2.2.Degree of Acidity

A. Principale

Dissolving a test sample in a mixture of solvents, then titrating the free fatty acids present using an ethanolic solution of potassium hydroxide.

B. Procedure

- Dissolve the test sample in 50 ml of the diethyl ether/ethanol mixture
- Titrate, stirring with the 0.1 mol/l potassium hydroxide solution until the indicator changes color (pink color of the phenolphthalein persisting for at least 10 seconds).

C. Calculation Formulas:

Acid Value:

$$AV = \frac{V \times N \times 56.1}{W}$$

Free Fatty Acidity (FFA) as a percentage of oleic acid:

$$FFA (\%) = \frac{V \times N \times 28.2}{W}$$

Where:

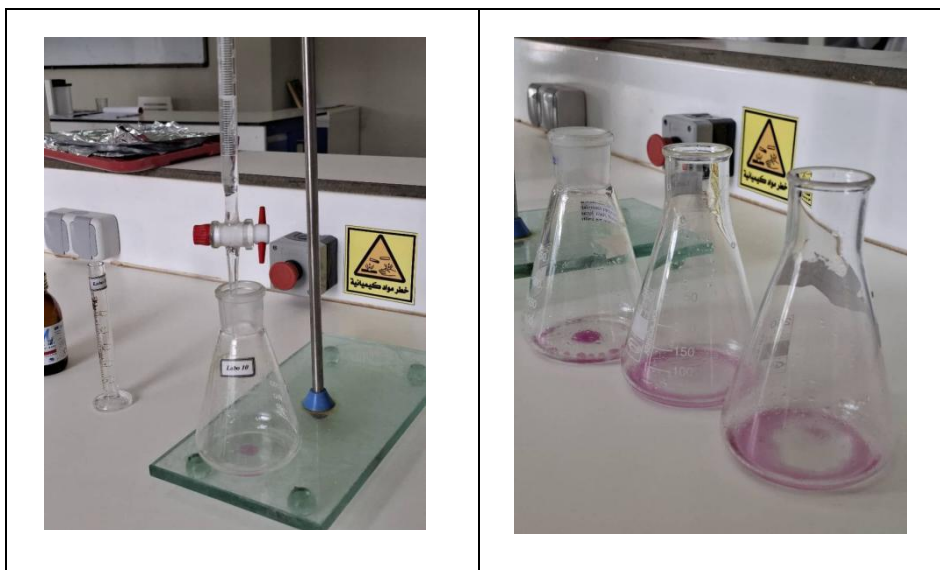
V: Volume of KOH used during titration (mL)

N: Normality of KOH (typically 0.1 N)

W: Weight of oil sample (g)

56.1: Equivalent weight of oleic acid (for Acid Value)

28.2: Conversion factor for FFA as % oleic acid



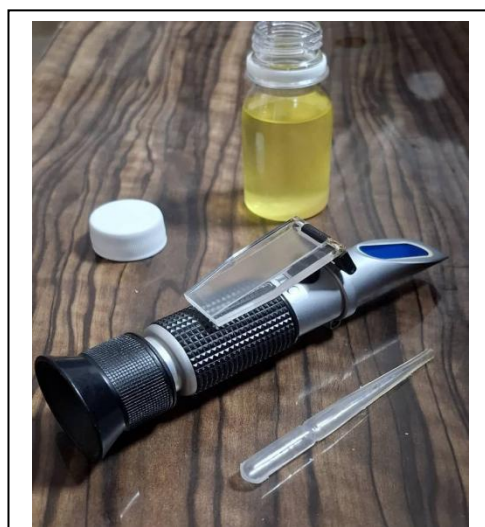
2.3. Refractive Index

A. Principle

The refractive index (RI) is the ratio of the speed of light in a vacuum to its speed in a material. It is widely used to assess the purity of oils or concentration of solutes. A refractometer allows direct reading of the RI after placing a sample between its prisms.

B. Procedure

- Clean the glass prism surface with ethanol-moistened cotton.
- Place 2–3 drops of oil sample on the lower prism.
- Close the upper prism to spread the sample evenly.
- Adjust the temperature (commonly 20 or 25°C).
- Read the refractive index directly from the digital display or the eyepiece scale (for optical models).



refractometer

2.4. Saponification Value

Number of milligrams of potassium hydroxide required to saponify 1 g of fat under the conditions specified in this method.

A. Principle

Reflux the sample with an ethanolic solution of potassium hydroxide, then titrate the excess potassium hydroxide with a standard hydrochloric acid solution.

B. Procedure

- Add 25 ml of the ethanolic potassium hydroxide solution and some boiling regulators to the test sample using the pipette .

-Connect the reflux condenser to the flask, place the flask on the heating device, and boil gently, stirring occasionally, for 60 minutes, except for fatty substances with a high melting point that are difficult to saponify, for which the boiling time should be two hours (2 h).

-Add 0.5 to 1 ml of the phenolphthalein solution to the hot solution and titrate with hydrochloric acid until the pink color of the indicator disappears. If the solution is strongly colored, use 0.5 to 1 ml of alkali blue solution (6b).

C. Calculation Formulas:

The Saponification index is equal to:

$$I_s = \frac{(V_0 - V_1) \times c \times 56.1}{m}$$

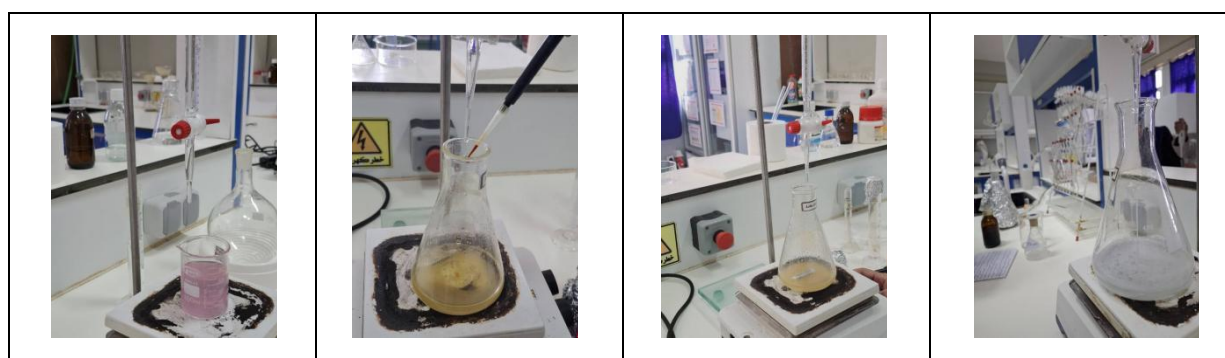
Where:

V₀: is the volume, in milliliters, of hydrochloric acid, used for the blank test;

V₁: is the volume, in milliliters, of hydrochloric acid, used for the determination;

c: is the exact concentration of hydrochloric acid;

m: is the mass, in grams, of the test sample.



2.5. Iodine Value

The iodine value was determined using the Wijs method, which measures the degree of unsaturation in fats and oils by determining the amount of iodine (I_2) that reacts with the double bonds in fatty acid chains.

A. Principle:

Iodine monochloride (ICl) in acetic acid reacts with the double bonds in the sample. The excess ICl is then reacted with potassium iodide (KI), releasing free iodine (I_2), which is

titrated with a standard solution of sodium thiosulfate ($\text{Na}_2\text{S}_2\text{O}_3$). The iodine value is calculated based on the amount of iodine consumed.

B. Calculation Formula:

$$I_2 = \frac{(V_b - V_s) \times N \times 12.69}{W}$$

Where:

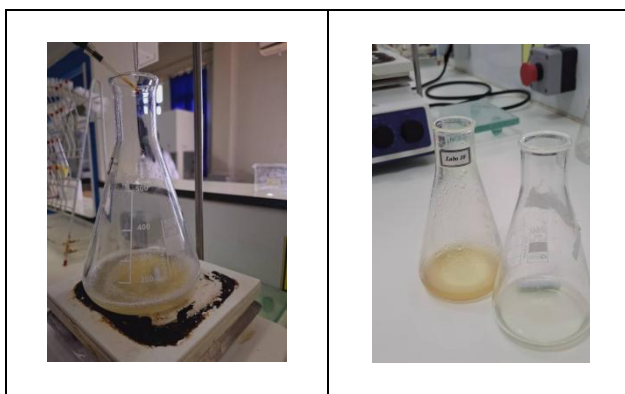
V_b = Volume of sodium thiosulfate used for the blank (mL)

V_s = Volume of sodium thiosulfate used for the sample (mL)

N = Normality of sodium thiosulfate

W = Weight of the sample in grams

12.69 = Milliequivalent weight of iodine $\times 100$ (1 meq I_2 = 126.9 mg)



2.6. Moisture content

A. Principle:

The oil sample is heated at 105°C until all moisture evaporates. The weight difference before and after drying is used to calculate the moisture percentage.

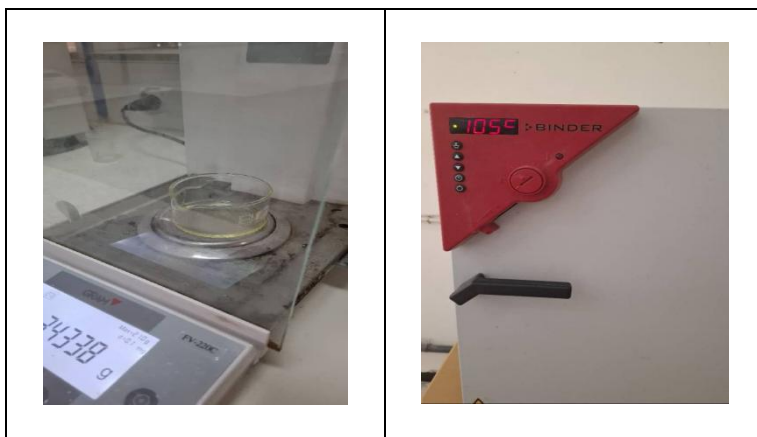
B. Calculation Formula:

$$\text{Moisture content}(\%) = \frac{W_1 - W_2}{W_1} \times 100$$

Where:

W₁ = Initial weight of the sample before drying (g)

W₂ = Final weight of the sample after drying (g)



2.7. Peroxide Value: IP Method

Procedure:

- Weigh 2.5 g of the tested oil into an Erlenmeyer flask.
 - Add 6 mL of chloroform, 9 mL of acetic acid, and 1 mL of saturated potassium iodide (KI) solution (0.5 g of KI dissolved in 1 mL of distilled water).
 - Stir the mixture for 1 minute.
 - Keep the mixture away from light for 5 minutes.
 - Add 35.5 mL of distilled water to the solution.
 - Add a few drops of starch indicator while stirring the mixture.
 - Titrate the solution with 0.01 N sodium thiosulfate ($\text{Na}_2\text{S}_2\text{O}_3$) until a pale yellow color appears.
 - Perform the same steps for the blank solution without using the oil sample.
- The peroxide value is calculated using the following formula:

$$IP = \frac{N \times (V1 - V0) \times 1000}{m}$$

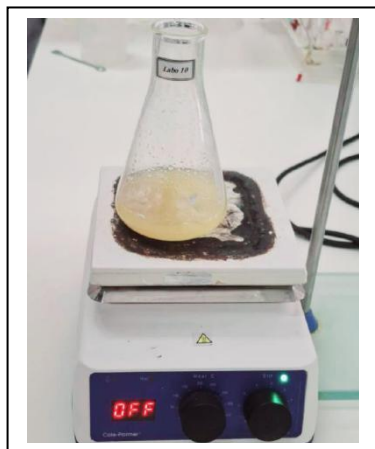
Where:

IP: Peroxide value (meq O_2 /kg of oil)

N: Normality of the sodium thiosulfate solution (0.01 N)

V1: Volume of sodium thiosulfate solution required for the titration (in milliliters)

m: Mass of the oil sample (in grams)



Conditions opératoires of GCMS :

Injecteur:

Température : 250°C

Mode d'injection : Splitless.

Volume injecté : 1µl

Colonne :

Type : HP-5MS

Dimensions : long 30 m * D int 0.25 mm * épaisseur film 0.25 µm

Phase stationnaire : 5% Phenyl 95% dimethylpolysiloxane. (Autre : Spécifier)

Température du four : 70°C pendant 5 min, 10°C/min jusqu'à 130°C., isotherme pendant 2 min., 3°C/min jusqu'à 220°C, isotherme pendant 4 min, 10°C/min jusqu'à 280°C., isotherme pendant 5 min.

Durée d'analyse : 58 min

Gaz vecteur : Hélium pureté : N6 ; Débit GV : 0.5 ml/min

Détecteur de masse :

Mode d'analyse : Scan TIC (de 30 à 550)

Délai du solvant : 3.5 min

Température de l'interface :280 °c

Type d'ionisation : Impact électronique

Intensité du filament : 70 év

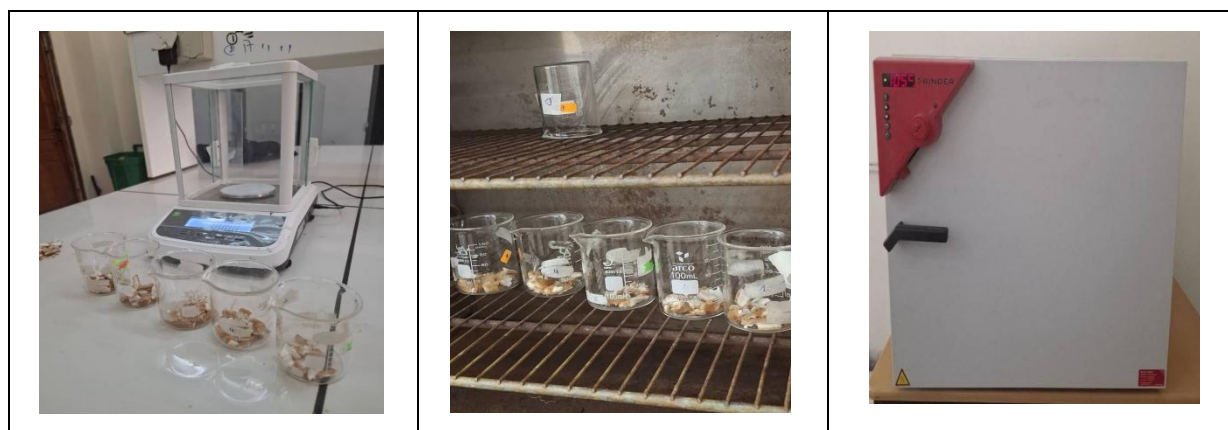
Type de l'analyseur de masse : Quadripôles

Température de la source : 230 °c

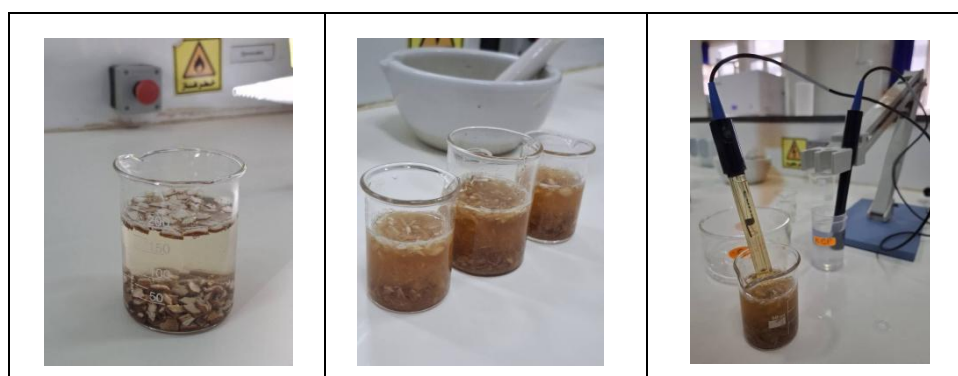
Equipement : Chromatographe : Hewlett Packard Agilent 6890 plus, Spectromètre de masse : Hewlett Packard Agilent 5973.

Appendix N°03: Physicochemical analysis of Degla-Beida Powder

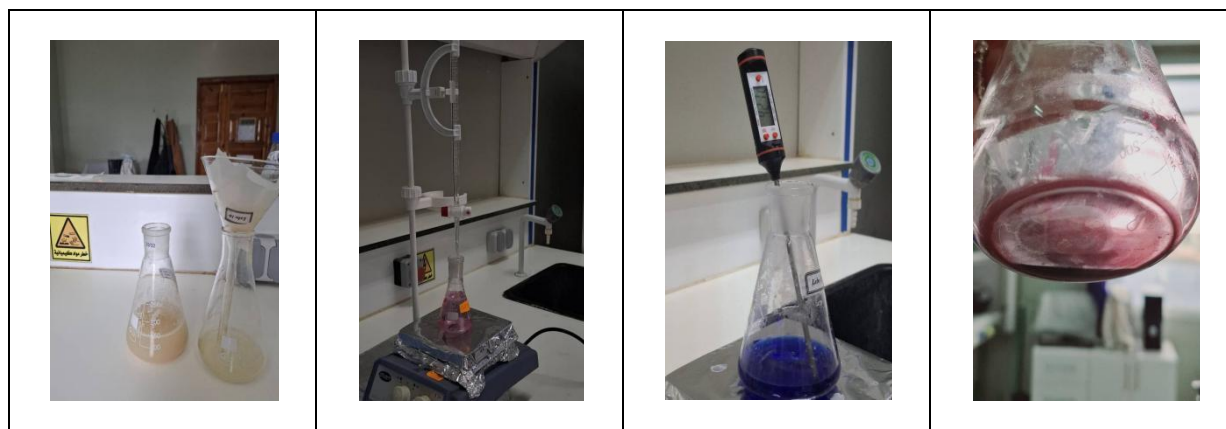
3.1. Moisture Content of Datte



3.2. pH



3.3. Total Carbohydrate Content



3.4.Lipid Content



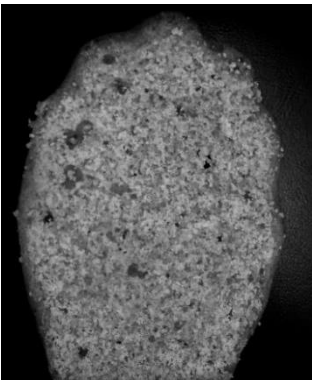
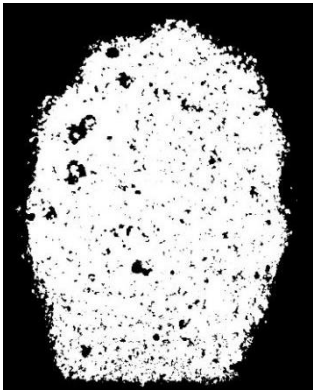
Soxhlet Method

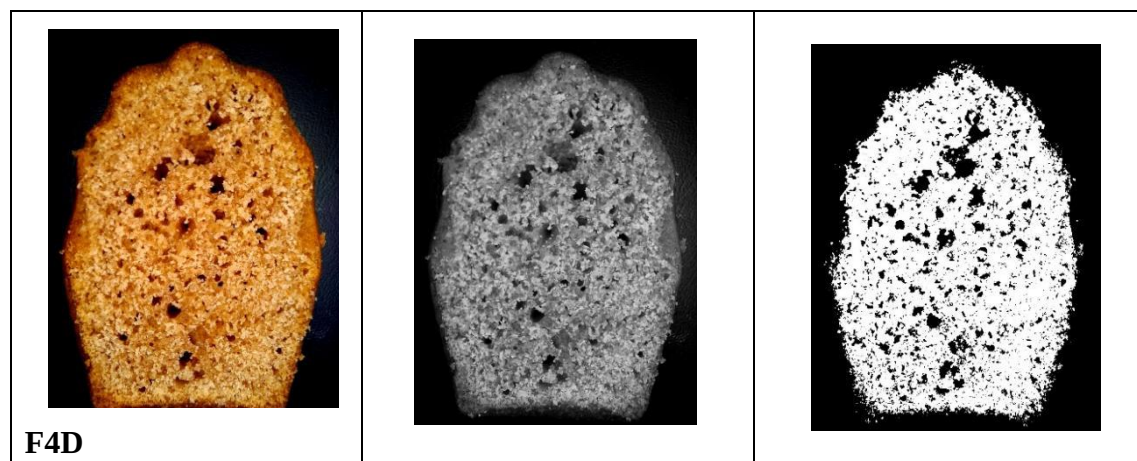


Rotary evaporator

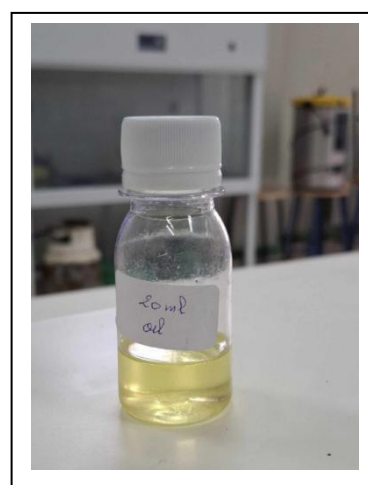
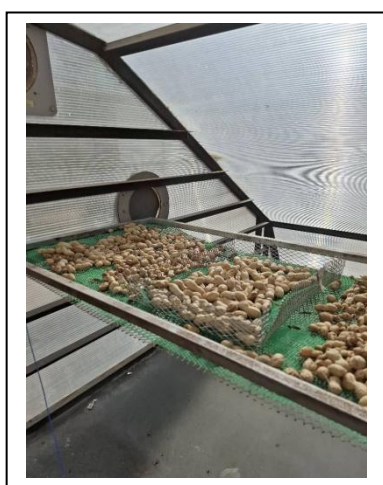
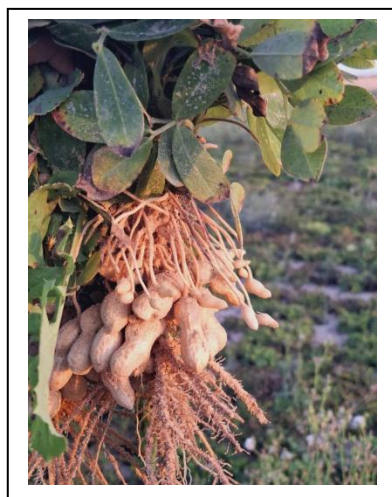
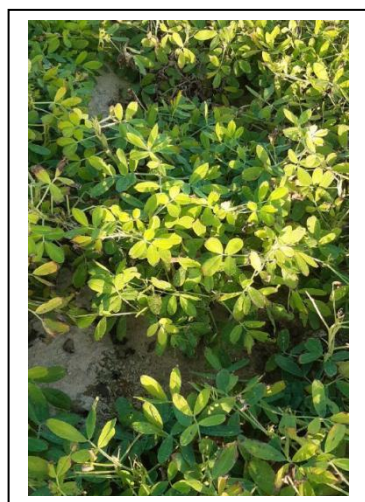


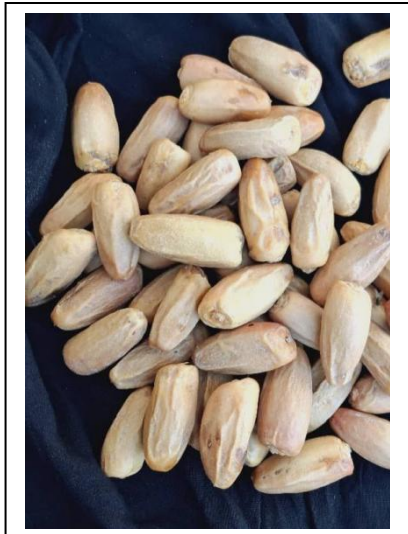
Appendix N°06:Longitudinal section of the madeleine samples analyzed using Image J software

Real Image	Picture of the picture set 8-bit	Binary image
 F1		
 F2P		
 F3PD		



Appendix N°07: pictures







Democratic and Popular Algerian Republic
Ministry of Higher Education and Scientific Research
Echahid Hamma Lakhdar University of El-Oued



**Production of an innovative product, "Healthy
"Madeleine with Peanut Oil and Deglah Beidha powder"**

**Project to obtain certification for an economic
establishment of the ministerial decision 1275**

Vitadele



University year

2025-2024

Supervision team	
Principal supervisor : Dr. Biya Bouras	Specialty : Science Alimentaire
Assistant supervisor : Dr. Touati Hicham	Specialty: International Trade

Project team	Specialty	Faculty
Cheriet Soundes	Biochemistry	SNV
Ghania Nour Elyakine	Biochemistry	SNV
Tedjini Farah	Biochemistry	SNV

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The first axis:
Presenting of the
project idea

I-The first axis: Presenting of the project idea

I-1-Project Idea

Our project falls within the food industry sector. The idea for this project arose as a result of the recent expansion of agricultural crops in Algeria, particularly in our region of El Oued. In this study, we focus on the proportion of deglah Beidha and peanuts, total production in all regions reaching **347.107 tones** . This has drawn attention to the need to exploit and enhance these products in the country's economy and diversify their consumption, particularly in the production of food products consumed almost daily by all segments of society. We focused on combining these two raw materials because they replace the most harmful substances to health: refined hydrogenated oils and glucose syrup, which we seek to eliminate in the coming years. We decided to combine these two ingredients to produce delicious Madeleine cookies that meet the standards of public taste, making them valuable in the food industry. Our project aims to develop techniques for exploiting agricultural crops in various productions. According to statistics, the total production of five types peanuts in the El Oued region reached **115.000 tones**, while the production of Deglah Beidha reached **232.107 tones** . Peanut oil is rich in unsaturated fatty acids and antioxidant compounds, making it an ideal choice for improving the nutritional value of the product. deglah Beidha powder, is an excellent source of natural sugars, fiber. **(According to the 2024 statistics of the Directorate of Agriculture in El Oued)**

Consumer awareness of nutritional health has increased over time, as has awareness of the harmful effects of pre-packaged products on the market, particularly their danger to young, growing children. This is achieved by limiting the proportion of sugars and saturated fats consumed. the development of the madeleine industry in Algeria enhances the added value of food products, contributes to strengthening the local economy.

This project aims to produce "healthy madeleines" using peanut oil and deglah Beidha powder as the main ingredients, given their high nutritional value and widespread availability in the valley region. This work is based on the principle of optimal utilization of local resources. Peanut oil is a rich source of healthy fats and antioxidants, making it a nutritious alternative to the saturated oils traditionally used in confectionery. deglah Beidha powder, is naturally rich in simple sugars, fiber, and minerals, making it a healthy alternative to glucose syrup and in madeleine production.

The project also aims to develop a manufacturing protocol that matches the properties of these ingredients, with a focus on maintaining the distinctive texture and flavor of the final product,

superior to commercial products on the market. The El Oued region was chosen as an ideal location for this project, given the abundant availability of raw materials, which facilitates manufacturing processes and reduces costs. Through this work, we hope to contribute to strengthening local food industries and encouraging innovation in the production of healthy foods that meet the needs of modern consumers, while simultaneously supporting the local economy by creating added value from abundant agricultural products.

I-2-Presentation of Product Value

- Healthy madeleine with two ingredients from a 100% natural plant source.
- Raw materials are widely available in the El Oued region, where peanuts contain healthy fats and antioxidants, deglah beidha contains minerals, fiber, and simple sugars.
- A natural product free of preservatives or artificial flavorings, such as additives and colorants.
- The two new ingredients are easy to combine with the usual ingredients used in madeleine production, as they are extracted in a way that helps add natural color and aroma to the madeleine.
- Replacing the usual madeleine ingredients, namely oil and glucose syrup , with peanut oil and deglah beidha powder provides a unique and refreshing product for the public in terms of taste, aroma, and color, meaning a delicious and highly acceptable result.

I-3- Sample Test

We carefully prepared the deglah beidha powder and extracted the peanut oil under suitable conditions. We conducted many tests for both in the college laboratory and in external laboratories, especially in Algiers.

The test results were as follows

it was observed that both peanut oil and deglah beidha powder are rich in highly nutritious compounds.

-Peanut oil is particularly abundant in healthy unsaturated fatty acids especially monounsaturated fats as well as 27 antioxidants such as vitamin C.

Furthermore, the oil exhibited a low acid value, a characteristic feature of high-quality oils. The refractive index, measured between 1.460 and 1.470, confirms the oil's purity and suitability for human consumption, in line with international standards for edible oils.

-Deglah Beidha powder, is an excellent source of dietary fiber, It is also rich in essential minerals such as magnesium and calcium, 78% carbohydrate content is high due to the variety of natural sugars, sucrose and fructose. The amounts of fat and protein, although relatively small, contribute appropriately to its nutritional value.

I-4-Work team

1. General Management (Chereit Soundes, Ghania Nour elyakine, Tedjini Farah)

The general management is responsible for the following tasks:

- Overall supervision of all project activities.
- Making strategic and critical decisions.
- Official communication with government bodies and partners (municipality, tax authorities, incubators, etc.).
- Legal representation of the company before the concerned entities.

2. Production and Food Processing Department

a. Head of Production / Chef (Chereit Soundes):

- Preparation and processing of the ingredients used in the “Vitadele Madeleines” product.
- Supervision of daily cooking and baking operations.
- Compliance with hygiene and food safety standards.

b. Production and Packaging Assistant (Chereit Soundes , Ghania Nour elyakine):

- Packaging of finished products in designated containers.
- Labeling the packages with identification and safety information.
- Organizing and storing the final products in an orderly manner.

3. Marketing and Sales Department (Ghania Nour elyakine)

- Digital marketing of the product via Facebook, Instagram, and WhatsApp.
- Managing online orders and responding to customer inquiries.
- Coordination with grocery stores, cafés, malls, and other outlets for product distribution.

4. Accounting and Financial Monitoring Department (Tedjini Farah)

- Preparing and monitoring the general project budget.
- Recording daily income and expenses.
- Preparing periodic financial reports for review and decision-making.

I-5-Project Objectives

- 1. Producing a healthy and nutritious food:** product rich in energy and vitamins, derived from natural and local ingredients.
- 2. Creating added value for agricultural products:** by transforming them into a marketable product.
- 3. Providing a healthy and natural alternative:** to processed or artificially sweetened snacks.
- 4. Utilizing local agricultural resources such as dates and peanuts.**
- 5. Developing local skills and knowledge:** implementing this project can contribute to developing local skills and knowledge in the production and use of agricultural crops in new and diverse production. Sharing experiences and knowledge with local experts and professionals will enhance local capacities in this sector.
- 6. Promoting public health:** Our healthy product is a rich source of fiber, minerals, natural sugars, and other essential nutrients. By improving the quality of the local product, healthy

food products can be provided to consumers, contributing to promoting public health and meeting nutritional needs.

7. **Expanding exports:** By achieving high quality and reliability in the local madeleine industry, or baked goods in general, exports to global markets can be increased. This opens up new business opportunities and generates economic revenue for the country..
8. Traditional commercial products such as madeleines often contain high levels of refined sugars or glucose syrup, hydrogenated oils, and flavor enhancers, all of which are associated with various health risks, especially over the long term. Therefore, the development of Vitadele - Madeleine, a healthy alternative made with peanut oil and powdered white dates instead of industrial ingredients, represents a promising option to reduce the nutritional burden linked to poor dietary habits, particularly among children.

Table01: Comparative Analysis of Traditional Madeleines and Vitadele Product

Component	Traditional Madeleines	Vitadele Healthy Product
Type of oil used	Hydrogenated or palm oil (linked to heart issues)	Natural peanut oil (rich in beneficial fatty acids)
Type of sugar used	Refined white sugar or glucose syrup	Powdered white dates (rich in fiber and minerals, low glycemic index)
Added nutritional value	Poor in vitamins and minerals	Rich in calcium, iron, magnesium, zinc, and copper (based on lab results)
Artificial additives	Often contains artificial flavors and colorants	Free from artificial flavors or enhancers
Glycemic impact	High glycemic index	Relatively low due to natural ingredients
Target group	General consumers without special dietary consideration	Children, diabetic individuals, and health-conscious consumers
Long-term health effect	Increased risk of obesity, diabetes, insulin resistance	Contributes to balanced and safe nutrition without harmful components
Total cost of production	Relatively lower due to the use of cheap commercial components.	Relatively higher due to the quality of natural ingredients

These are some of the potential objectives of a healthy madeleine production project. Numerous economic, social, benefits can be achieved through the successful implementation of this project.

I-6-Schedule for project realization

Table02: Schedule for project realization

N°		Month 01	Month 02	Month 03	Month 04
01	Preliminary study: choosing the headquarters of the production unit and preparing the required document	✓			
02	Purchasing machines, selecting workers and training them.		✓		
03	Preparing the production unit headquarters.		✓	✓	
04	Purchase of raw materials.				✓
05	Start of first production				✓

The second axis:
Innovative aspects

II-Axis Two: Innovative Aspects

The project aims to achieve innovation and renewal in the food industry by producing healthy madeleine using two previously uncombined ingredients: peanut oil and date powder

II-1-Research and Development

-It is essential to pay significant attention to research and development to establish specifications for oil extraction and date drying using easy and safe techniques and methods.

II-2-Product Diversification

-Study the properties of the oil and powder to raise public awareness and meet diverse market needs.

-Meeting consumer demands by offering a healthier alternative to conventional harmful biscuits currently available in the market, with plans to diversify the product range by introducing various flavors in the future.

II-3-Improving Health Properties

-Focus on developing the properties of the two components (oil and powder) by enhancing and improving their nutritional value without resorting to refined oils and glucose syrup.

II-4-Sustainability and Social Responsibility

- Consider sustainability in production processes.

- Explore opportunities to create a positive social impact, such as creating job opportunities in the local community.

II-5- communications

-Interaction with customers to understand their needs and expectations in order to improve the product over time.

II-6- Innovation in production processes

-High quality production by examining the improvement of production processes using modern technologies, thereby increasing production efficiency and improving product quality.

II-7- Strategic partnerships

-Seeking strategic partnerships with farmers, suppliers and academic institutions to promote sustainable development and innovation.

II-8- Quality Guarantee

-Establishing strict quality control procedures at all stages of production to ensure the delivery of a product meeting the highest standards.

II-9- Innovative packaging

-Using innovative design for the packaging of madeleine,helping to attract attention to the brand.

II-10-Price

-Appropriate and competitive pricing compared to the prices of products available on the market.

II-11-Waste valuation

- the use of waste in the production of other products.

II-12-Project Prospects (Future Vision)

In the near future, our company aims to diversify its food products by expanding its range to include the production of various alternative food items. Our objective is to provide innovative and efficient solutions to enhance the quality and performance of these food products, thereby meeting the diverse needs of the market and strengthening our position in the food industry.

This project represents a fundamental first step in our journey toward developing healthy food alternatives to many harmful products that are consumed daily or weekly by large segments of the population, despite their known negative health impacts. Through this product, we aim to establish a solid foundation for creating a diverse range of healthy foods that meet the needs of the modern consumer in terms of quality, taste, and nutritional value, without compromising food safety standards. This approach not only seeks to improve dietary habits, but also aspires to bring about a positive shift in overall consumption patterns and to promote a culture of mindful and sustainable nutrition within society.

The third Axis:

strategic

analysis

the

market

III-The third axis : strategic analysis the market

III-1- Market segment offer

III-1-1-The potential market

It is every consumer who wants to maintain his health and the health of his children and diabetics, and commercial centers (such as stores, cafes and supermarkets), hotels, restaurants and airlines

III-1-2-Target market

We seek to provide our product "Healthy Madeleine " to several categories of customers:

- **Children:** Because they are the primary consumers and the first to be harmed by the various types of sweets available in the markets that have no nutritional value for the child.
- **People with chronic diseases :** They are people with diabetes
- **Dieters :** They are people who follow a diet for a specific goal, such as losing weight or building muscle.
- **Healthy Consumers :** They are people who care about maintaining their health and follow a healthy lifestyle. They prefer to eat natural and healthy foods .We have targeted these groups of people because they refrain from eating sweets previously due to health conditions, due to the high amounts of sugar, artificial flavors and preservatives and dyes that these sweets contain that negatively affect their health.Chronic diseases like Diabetes and obesity in children and adults have also become a global problem, and their numbers have witnessed a remarkable increase in recent times. We have also noticed that there is an increasing interest in health and the trend towards a healthier lifestyle through the increase in the number of dieters. Including the growing demand for natural and healthier products.

III-2- Measuring the intensity of competition

III-2-1-Identifying competitors in the Algerian market

The market for industrial baked goods, especially madeleine cakes, is one of the dynamic and highly consumed segments in Algeria. Despite the large presence of conventional brands offering madeleines rich in hydrogenated fats and refined sugars (glucose syrup), the demand remains strong due to the widespread habit of daily consumption among children and adults alike. Unlike seasonal products, madeleines are consumed consistently throughout the year, particularly during breakfast or as a snack with tea or coffee.However, the market lacks truly healthy alternatives tailored to emerging consumer trends that prioritize natural ingredients and nutritional value. Currently, there is no major brand offering industrially produced, health-focused madeleines without added sugars or hydrogenated oils. As such, competition in the healthy segment is still limited or indirect, with occasional homemade recipes shared online but without commercial-scale availability. This presents

a significant opportunity for Vitadele to establish itself as a pioneering brand in this niche, especially among health-conscious consumers, parents, and individuals with dietary restrictions.

●**Direct competitors** : There are no direct competitors to our organization. Due to the characteristics and advantages that our Vitadele Madeleine possesses.

●**Indirect competitors** : There are no indirect competitors to our organization. There are traditional madeleine brands, but they rely on white sugar, hydrogenated oils. There are no well-known local brands that clearly market themselves as "healthy" madeleines or a safe food alternative for diabetics or children. Some mothers or content creators post homemade recipes for "healthy madeleines", but there is no commercially packaged, ready-made product with this concept, quality, and nutritional value.

III-2-2-SWOT strategic diagnosis



Figure O1 : SOWT Analysis

Our organization's future strategy can be analyzed by analyzing strengths and weaknesses, opportunities and threats as follows:

Table 01 : Internal factors

Strengths	Weaknesses
-Experience and high professionalism of a project team. -Product quality. -Youth workforce. - Advanced and modern equipment. - Raw materials are 100% local.	-Weak financing capacity. - Brand new and unknown.

-A healthy madeleine .	
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Table 02 : External Factors

Opportunities	Threats
- Changing consumption trends towards healthy and natural products. -Increased demand for haelhy sweetes. - Gain customer satisfaction. -Expansion of production lines. - Lack of competitors.	-Product imitation. - High prices of raw materials - Weather conditions that may affect the prices of raw materials

Table 03 : SWOT matrix

	Strengths	Weaknesses
Internal factors	Professional competencies - labor force - quality - healthy products - advanced equipment	Weak Funding Capacity - Brand – Unknown
External factors		
Opportunities	Offensive strategy	therapeutic strategy
Changing consumption trends - gaining satisfaction - expansion - lack of competition	Using strengths to invest in available opportunities	Addressing weaknesses and investing in available opportunities
Threats	defensive strategy	deflationary strategy
High prices of raw materials - weather conditions – imitation	Use strengths to reduce of threats	Reduce vulnerabilities and reduce threats

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Through SWOT analysis, our organization shows four different strategies that can be adhered to in the organization's environment, we find: □

- **Offensive strategy** : In this case, our organization must use strengths to invest in available opportunities.
- □ **A remedial strategy** : In this case, our organization must address weaknesses and invest in available opportunities.
- □ **Defensive strategy** : In this case, our organization must use strengths to reduce threats.
- □ **Contractionary strategy** : Our organization, in this case, has to reduce weaknesses and reduce threats.

III-3 - Marketing strategies

Our organization will take marketing as a main means to achieve its goals, especially with regard to increasing the profits of the organization, knowing the desires and needs of the public, and trying to satisfy its desires, thus maintaining its position in the market and achieving maximum profit and establishing a distinguished position for our organization in the market, which increases its market share. In order to achieve this, we have prepared a marketing strategy that enables us to produce according to market requirements and create a competitive advantage through quality and price. Marketing is a process of planning and implementing our business activity that aims to achieve the goals of our organization, and accordingly we will rely on four elements that work in an integrated and homogeneous framework that are represented in the marketing mix 4Ps, which are the product strategy, the price strategy, the distribution strategy and the promotion strategy.



Figure 02 : The 4Ps of marketing

III-3-1-Product strategy

We will rely on a set of characteristics in order to make our product "Healthy Madeleines " distinct from other commodities " traditional madeleines" through the following : □

- **Technical characteristics :** The technical characteristics of our product are mainly represented in the physiological aspect of the madeleines , and therefore we will focus on the quality advantage in the composition of the madeleines and make it a healthy, very soft and unique madeleines. □
- **Formal characteristics :** The formal characteristics of our product are mainly represented in the original Madeleine, distinctive branding and packaging

III-3-2-Pricing Strategy

The pricing strategy is a very important method for our organization to price our product in line with the current market demand, through which it aims to increase our sales and profits while continuing to stay in the market by selling our product at reasonable prices. In addition, price is one of the marketing mix components, which is closely related to other marketing mix components. The price may also encourage customers to make a purchase decision, so we must take an appropriate marketing strategy. However, there are many factors that may affect the determination of the price, and we must take them into consideration, including what is external and what is internal, namely:

- **External factors**

-**Demand :** Demand for our product is one of the factors affecting price determination. The rise and fall of prices is usually associated with an increase in demand and a decrease in it as well. The individual income of customers is controlled by it, as the higher the income of individuals, the greater the demand.

-**Competition :** that there are traditional madeleines in the market, it greatly affects the policy of determining the price of our product, and therefore it cannot in all cases exceed market prices, especially since our brand is not traded in the market before.

- **Distributors :** The distribution policy that will be followed by our two institutions is considered one of the factors affecting the pricing of our product, so resorting to relying on small distributors, unlike large distributors who control distribution prices, as they usually resort to reducing selling prices, with the aim of maximizing the quantity sold.

- **Suppliers :** Suppliers are considered an influential party in our organization's ability to determine the price of our product, especially when they raise the prices of raw materials. In this case, our organization is forced to raise the selling price of our product, or sometimes we have to reduce the profit margin that our organization plans to obtain. □

- **internal factors**

- **Costs** : Pricing policy in our organization may be affected by the level of production and marketing costs, as the profit target by our organization requires that the unit selling price of our product be sufficient to cover production costs plus the profit margin.

- **Stages of the product life cycle** : Our product goes through four basic stages, which are emergence, growth, maturity, and decline. These four stages have a direct impact on pricing policy, as the price changes with each stage of the life cycle of our product, as:

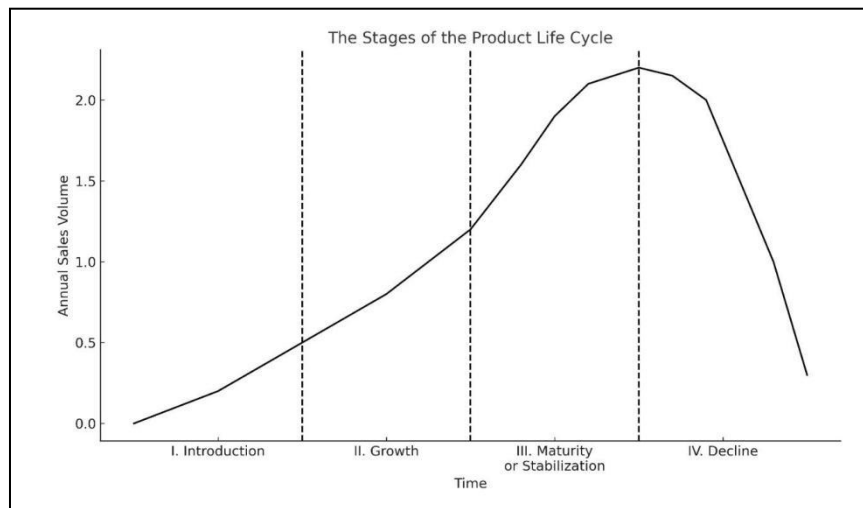


Figure 03 : The curve represents the Stages of the product life cycle

- **Emergence stage**

In this stage we display our product for the first time in the market, and it is considered to be the most difficult stage that our product goes through during its life cycle, and therefore this stage needs to secure large budgets in order to spend effectively on marketing research that is conducted on the product and market Competition, as the data of this stage is different from other stages in terms of the small size of the market and the small number of competitors at the beginning, which means a decrease in the volume of sales and thus a decrease in profits. Accordingly, our organization resorts to setting a high price for our product in order to cover and recover costs and raise profits. Hence, this stage contributes to raising awareness about the product and introducing the target audience to the nature, features and benefits of this product for them.

- **Maturity stage**

At this stage, our product reaches a great degree of prosperity and achieves a great position in the market among competitors. Accordingly, our organization reaches the peak of profits. The competition also increases here, and every product seeks to obtain a share of the market, and this is due to the fact that the consumer has multiple options, which prompts us to search for ways to satisfy the consumer and push him to purchase our product, by reducing the price.

- **Decline stage**

It is the last stage in our product life cycle. At this stage, the sales volume begins to decline due to the emergence of newer products and consumers' pursuit of innovation and finding different

advantages and characteristics in different products, which prompts our organization to maintain the existing customer base and the same sales number by searching for new customers and satisfying them through discounts and offers. Attractive gifts and other innovative means.

Therefore, our organization will rely on cost-based pricing policy. It is the most common pricing method in which the price is determined by adding a profit margin to the cost of the product.

The pricing process is as follows:

$$\text{Price} = \text{Costs} + \text{profit margin}$$

Our organization will also determine the minimum price and the highest price required for our product. On the other hand, our organization can adjust the price of our product and reduce it to coincide with market conditions and seasons, by relying on discounts such as quantity discounts, trade discounts, and cash discounts.

III-3-3-Distribution strategy

Distribution is one of the main components of the marketing mix strategy, and it is also a link between Our organization and our customers, through which our organization targets the market segment that we have chosen and meets the desires and needs of the targeted consumers efficiently and profitably to ensure survival and continuity in the market. Therefore, t contributing to the disposal of our product and its delivery from the place of production to the place of consumption in an easy and fast way, while ensuring that it arrives in a timely manner. It also has an effective role in gaining consumer satisfaction. Thus, our organization will rely on the strategy of intensive distribution by resorting to distribution channels and distribution institutions in marketing our product. This is a strategy that uses one or more brokers,Through the following :

III-3-3-1- Distribution channels

III-3-3-1-1-Intermediate distribution channel: This channel uses only one mediator represented by the retailer as follows:



III-3-3-1-2-The long distribution channel:the number of intermediaries in this channel is two or more, according to the follows:



Thus, we will rely on distribution agents across all states of the country to bring our product closer to consumers.

III-3-3-2- Distributive Institutions

The distribution institutions are capable of undertaking the distribution process, and these institutions include: retail stores, wholesale stores and agents. But since our company is new in the market. Especially, there are giant leaders who control the market, so there is a caution from the distributors regarding the distribution of our product so as not to cause them losses, and waste their capabilities without return, and given that we do not have the large financial capabilities in order to entice them. In this case, we will rely on the Pull Marketing Strategy to generate demand for our product.

III-3- 4 - Promotion strategy

It may not be enough for our organization to design a product that is suitable for consumer desires or even to set attractive prices unless it is accompanied by an effective promotional strategy, especially when we display our product for the first time in the market, so we must follow an intensive promotional strategy. Promotion has a major role in informing, persuading and reminding consumers of our product. In addition to identifying the audience's opinions and trends by presenting the message to the public, and in order to achieve this, we use all means that enable us to deliver the advertising message to our target customers. This is done by communicating in several ways, namely:

III-3-4-1- Advertising

Because it aims to inform consumers of different categories of the existence of our product, mentioning its benefits, and trying to convince them to buy it. It also works to increase and stimulate the sales of our organization. This is done through advertising and publicity in various media, namely :

III-3-4-1-1- Non-print media

Which is divided into audio, visual and electronic means, including:

- **Radio**

Our institution will rely on it as a media medium due to its characteristics. It is considered radio as one of the effective means of media at the local and national levels through broadcasting stations, as the radio allows illiterate listeners who do not read or write the opportunity to obtain news. The listener can also perform various activities while listening to the radio without needing effort or trouble. And the possibility of continuing its broadcast around the clock, which enables the audience to determine the appropriate time to receive the broadcast in any place and time.

- **Television**

Television is considered one of the most influential media, because it enjoys a large audience among people, and its power in public opinion in society. For this reason, our organization will publish advertisements on channels that are more watched by the Algerian people, specifically at the peak viewing time in the evening.

- **The Internet**

The Internet now occupies an important place in electronic journalism and new media, through the following:

- **Social networking sites**

Our organization will open several accounts on all social networking sites (Instagram, Tik Tok, Facebook, Twitter, Pinter-est, You Tube). So that our organization will invest in Facebook and Instagram since they are the most used social networking sites by the Algerian people. You will also prepare an electronic platform at the level of Google for our organization. It will also rely on several social networking sites to communicate with customers (G mail, Messenger, Whats App, Viber, IMO, Telegram) and receive complaints. □

- **Electronic newspapers**

Our organization will rely on electronic newspapers because they are characterized by many communication characteristics that made them a fast means of conveying news.

III-3-4-1-2-Print media □

- **Newspapers**

Newspapers are an official source of many news and data. It also has the ability to read it at any time and place. Therefore, our organization will rely on publishing its advertisements in newspapers to reach the largest possible audience.

- **Advertising signs**

They are large-sized outdoor signs, often placed in high-traffic places, aiming to provide advertisements to passers-by. Accordingly, our organization will prepare posters containing advertisements, then they will be placed on billboards distributed in the streets and public spaces. These posters can also be placed on various means of transportation. Which contributes to the continuous reminder of our product due to the repetition of watching it daily and perhaps several times per day for a long time. We will also rely on several types of advertising, namely :

- **Media advertisement**

The objectives of this advertisement are to present and introduce our product when it first enters the market and create the initial demand for it. Thus, our organization will use it in the early stages of our product life cycle.

- **Persuasive advertising :**

The objectives of this advertisement is to persuade the consumer to prefer our brand and to reach categories of individuals that the salesman cannot reach. This advertisement also tries to convince the consumer to respond to the call to buy. Thus, our organization will use it in the growth phase and the beginning of the maturity phase of our product life cycle.

- **Reminder advertisement**

The goal of this advertisement is to keep our product in the memory of the consumer and to preserve our customers, and therefore our organization will use it, especially in the last stage of the life cycle of our product.

III-3-4-2- Activate sales

This activity aims to increase the volume of sales by urging and motivating consumers to buy our product by offering them prizes in return for consuming our product. It is also intended for brokers and sellers. And the means of stimulating sales include many methods, including free samples, discounting the price, and presenting a gift to the most consumer of our Madeleine's.

III-3-4-3- Public Relations

Our organization seeks, through public relations, to win the loyalty of workers from within the VD Foundation. Abroad, its goal is the support, endorsement and cooperation of all other parties such as customers, suppliers, banks, distributors and the media.

III-3-4-4- Personal Selling

Our organization will depend on this element in the case of the stage of the appearance of our product. With the aim of persuading the members of the distribution channels of our product. Whereas, the sales team affiliated with our organization carry out advertising activities directly on the final consumers. Faisal is the role of salesmen to the extent of persuading the consumer to buy and re-purchase and even reach loyalty to our product. Our organization will rely on two main promotional strategies represented in:

III-3-4-4-1- Push strategy

Our organization seeks, through its use of this strategy, to achieve its goals related to distributing our products and increasing sales by focusing promotional as our organization promotes our product to the nearest link in the distribution channel represented in the wholesaler, for example. Convincing him to buy our product, and the latter, in turn, seeks to persuade the retailer to deal with our product, as he is in the end promoting the product to the final consumer. The focus of this strategy is on the two elements of personal selling and commercial offers in the promotional mix.

III-3-4-4-2-Pull strategy

Through this strategy, our organization seeks to achieve its sales goals by bypassing sales intermediaries by focusing its promotional efforts on final consumers directly by persuading them to buy our product, and then creating demand for it by going to product, where the focus in this strategy is on advertising as one of the elements of the promotional mix.

- The marketing strategies of our organization can be summarized in the following scheme:



Figure 04:Summary of marketing strategies in our organization

III-4- Market study

III-4- 1-Practical design of the study

III-4- 1-1- Study methodology

The study is based on the use of the survey method, as it seeks to measure the actual position of the Healthy Madeleine "Vitadele" in the eyes of the Algerian consumer by collecting information using a questionnaire tool addressed to a sample of peoples at the national level.

III-4-1-2- Sample installation

In the market study, the results are taken and collected from the questions posed to a sample of the studied society (the target group). The sample size consisted of 667 individuals distributed over the

entire national territory. It was collected using the electronic questionnaire technology, as programming allows receiving only completed survey lists.

III-4-1-3- Formulating the questionnaire and analyzing the results

The questionnaire was formulated in a way that provides the necessary data for the study, which included the following questions: □

- Part one: closed questions related to the personal data of the study sample.
- Part Two: Questions aimed at determining the consumer's opinion of our " Vitadele " Healthy Madeleine, including determining the extent to which this product is located.
- Part Three: Questions related to determining the purchasing behavior of consumers and identifying the most important marketing methods.

III-4-2-Analyzing and discussing the results of the study

III-4-2-1- Characteristics of the sample items

The following is an accurate description of the personal characteristics of the study sample:

Table 04: Distribution of the study sample according to personal characteristic

Age	The number	Percentage
Less than 18	8	1,2%
Sex	The number	Percentage
18 - 25	363	56%
26 – 40	238	36,7%
Over 40	39	6%
Academic level	The number	Percentage
Primary	5	0,8%
Middle	9	1,4%
Secondary	71	11%
University	531	82,1%
Other	31	4,8%
Total	667	100%

The descriptive statistical analysis of the sample's items indicates that the largest segments contributing to the study sample are females, with a rate of 68.6%, while the male category represented 31.4%, and the largest segment in terms of age group was between 18-25 years, with 363 individuals, or 56%, followed by the category between 26-40 years old, with a rate of 36.7%. In terms of educational level, university students represented the largest segment of respondents , representing 531 individuals 82.1%, followed by high school students, representing 11%.

Table 05 : Sample members answered whether they suffer from diseases, diabetes or obesity

Options	The number	Percentage
I have no diseases	559	86,4%
I suffer from obesity	21	3,2%
I suffer from diabetes	9	1,4%
Other	58	9%
Total	667	100%

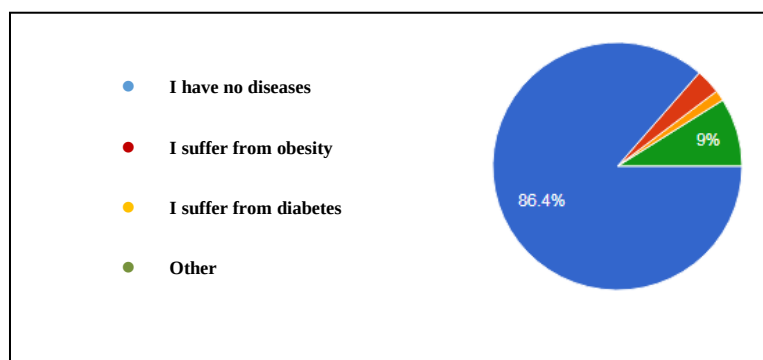


Figure05: A relative circle representing whether they suffer from diseases, diabetes, obesity, or other diseases.

The survey shows that 86.4% of participants were free of disease, indicating that most of them are in good health and would consider a healthy product as a preventative option.

On the other hand, 9% of participants were obese, highlighting the need for light, trans-fat-free food alternatives.

The other small percentages (diabetes and other diseases) indicate a small but dire need for healthy products free of sugar and harmful substances.

These results confirm the importance of "Vitadele" as a suitable option for multiple groups.

Table 06: The answer to the question of whether they care about the quality of food or not

Options	The number	Percentage
Yes	276	42,6%
No	55	8,5%
sometimes	317	48,9%
Total	667	100%

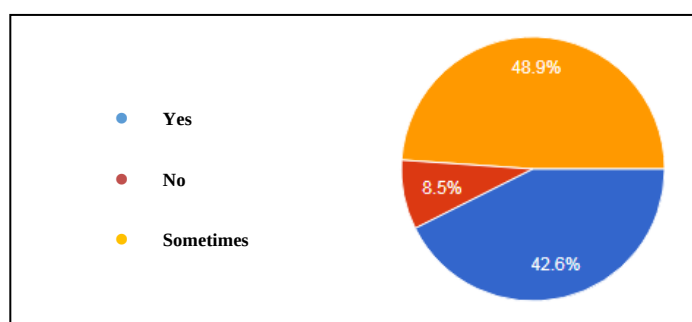


Figure06: A relative circle representing the percentages of whether the sample members care about the quality of the product or not.

The department indicates that 42.6% of individuals care about product quality, an encouraging percentage that indicates growing consumer health awareness. Conversely, 48.9% are not concerned, indicating the need to increase awareness about the importance of choosing high-quality products. 8.5% are sometimes concerned, which represents an opportunity to attract them to a consistent, healthy product like "Vitadele".

Table 07 : Study sample consumption of artificial sweets How often do you consume industrial confectionery product

Options	The number	Percentage
Daily	82	% 12,7
2-3Times/week	261	% 40,3
Rarely	275	% 42,5
I don't take	29	% 4,5
Total	667	% 100

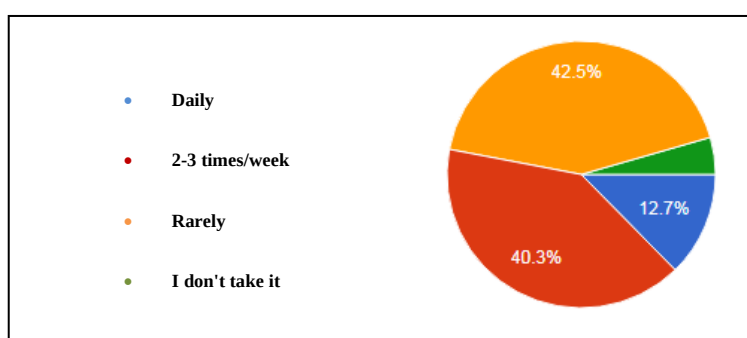
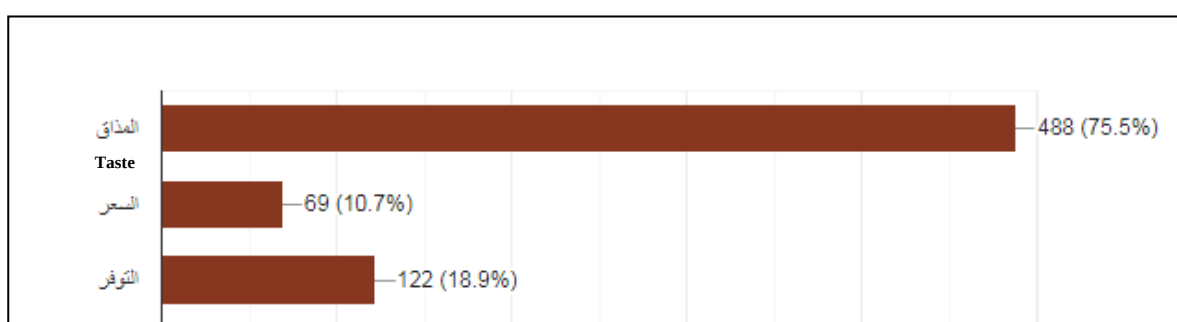


Figure07: A relative circle represents the percentage of people's consumption of artificial sweets.

Based on the results, it appears that the majority of the study sample, 42,5%, consume artificial Rarely, While another 40,3% reported that they consume it 2-3 times a week, and a small number12,7% of them reported that they consume it daily. This indicates a good opportunity to increase demand for the product and achieve high sales.

Table 08 : Determining the criteria for attracting consumers to purchase ready-made sweets within the study sample

Options	The number	Percentage
Taste	448	75,5%
Price	69	10,7%
Availability	122	18,9%
Brand	75	11,6%
Other	87	13,5%
Total	667	100%



Price

Availability

Brand

Other

Figure08 : Bar charts representing the number of people who consume ready-made sweets and the criteria for attracting them to buy them

The results showed that 75% of the study sample consumes artificial sweets based on taste. Another 18,5% consumes them based on availability, 11,6% based on brand, and a small percentage of the sample 10,7% consumes them based on price. This is considered a positive sign for the success of our project.

Table 09: Answering the question of whether people prefer products with healthy properties or not

Options	The number	Percentage
Yes	403	62.5 %
No	67	10.4 %
I don't care	175	27.1 %
Total	645	100 %

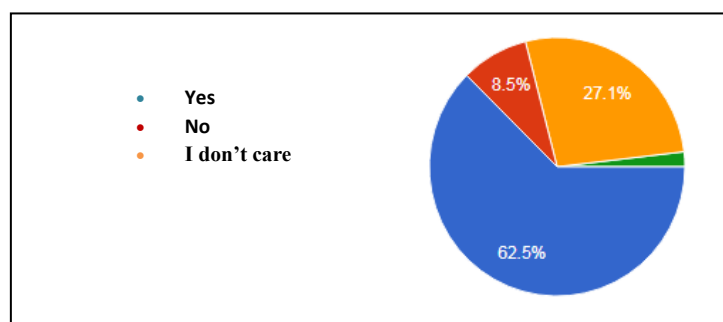


Figure09: A relative circle representing the percentage of people's interest in health products.

The department explains that 62.5% of participants are interested in health products, a positive indicator that encourages the development and marketing of products like "Vitadele" that meet this health trend.

Table 10 :The sample's opinion on the idea of healthy madeleines

Options	The number	Percentage
Excellent	432	66,8%
Good	147	22,7%
Average	50	7,7%
Not Interested	18	2,8%
Total	667	100%

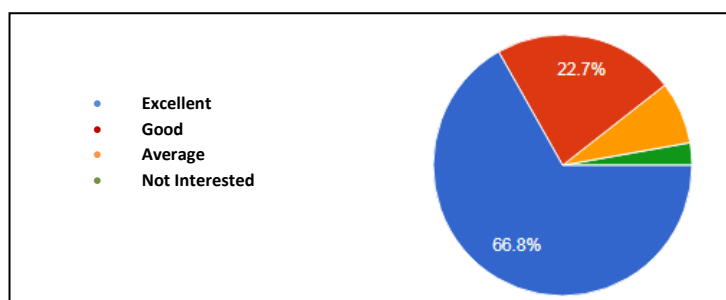


Figure10:A relative circle representing the opinions of the studied sample regarding the idea of healthy Madeleine

It turned out that the majority of the sample studied stated that the idea of the healthy madeleine is excellent, with a percentage of 66,8%, and 22,7% thought it was a good idea, while a small group of the sample stated that it was an ordinary idea for them, and this encourages our idea and motivates us to continue implementing our project.

Table 11: Opinions of the sample members studied about the appropriate price for a healthy Madeleine box containing 6 units

Options	The number	Percentage
Less than 100 DA	245	37,9%
100-150 DA	332	51,4%
150-200 DA	60	9,3%
More than 200 DA	9	1,4%
Total	667	100%

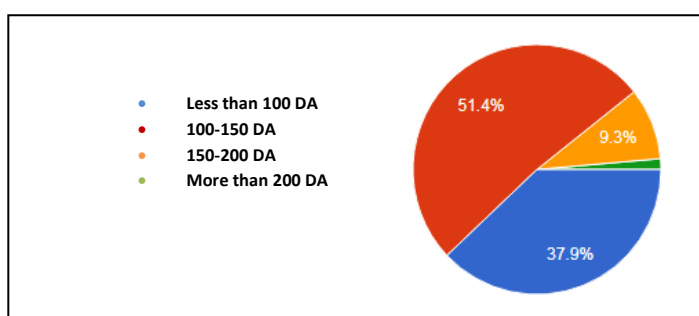


Figure11: A relative circle representing the results of the opinions of the studied sample regarding the appropriate price for a healthy Madeleine box containing 6 units.

The results show that acceptable prices range between 100 and 150 Algerian dinars, as a large number of people are willing to pay these prices for a box of healthy Madeleine containing 6 units. Based on this information, we determine the appropriate price for our product so that it is suitable for consumers, covers production costs, and contributes to the project's profitability.

Table 12: The extent of the sample's readiness to try the product

Options	The number	Percentage
Yes	598	92,6%
No	15	2,3 %
Not Interested	33	5,1%
Total	667	100%

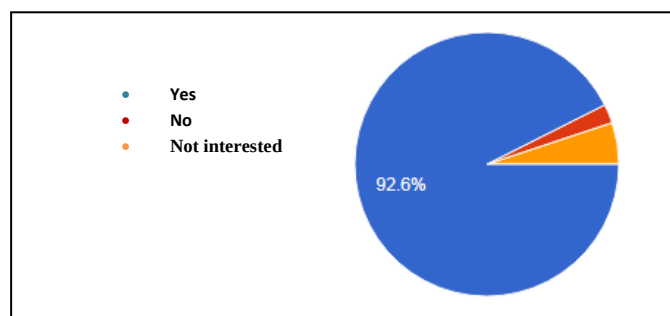


Figure12: A relative circle representing the extent of the sample members' willingness to try the product.

The results showed that the majority of the sample members were ready to try our product, This is considered our support in completing our project and the success of the idea.

Table 13: Answer to the question Do they consume certain brands of madeleines or cakes

Options	The number	Percentage
Yes	211	24%
No	281	43,4 %
Not Interested	155	22,6%
		100%

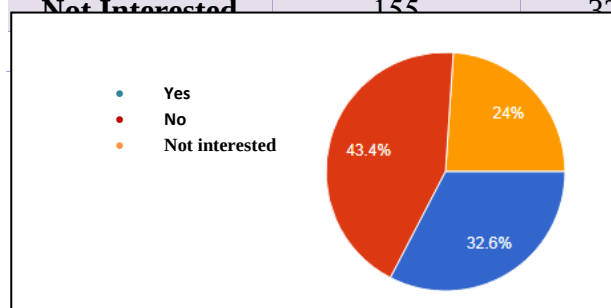


Figure 13: A relative circle expressing whether the sample members use a specific brand of industrial products.

According to the sample results, it was found that the majority of the sample do not use a specific brand 43,4 %. A percentage 32,6% of them say that they are not interested, and this indicates that the sample members will accept the idea of our product.

Table 14: The opinion of the sample members studied about the quality of industrial products

Options	The number	Percentage
Excellent	131	20,5%
Acceptable	447	70,1 %
Weak	60	9,4%
Total	667	100%

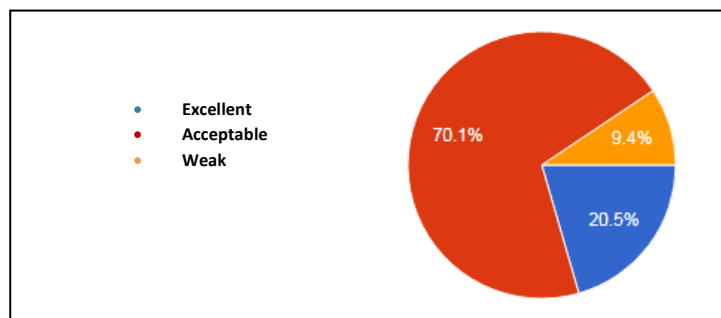


Figure14: A relative circle representing the sample's results regarding their opinion on the quality of industrial confectionery products.

The sample results showed that the largest number of the sample stated that these products are unhealthy 70,1 %, with a percentage 20,5% of those who answered that they are acceptable, and this supports the idea of our project.

Table15: Sample members' belief whether these products are healthy or not

Options	The number	Percentage
Yes	87	13,9%
No	350	54,5 %
No knowledge	205	31,9%
Total	667	100%

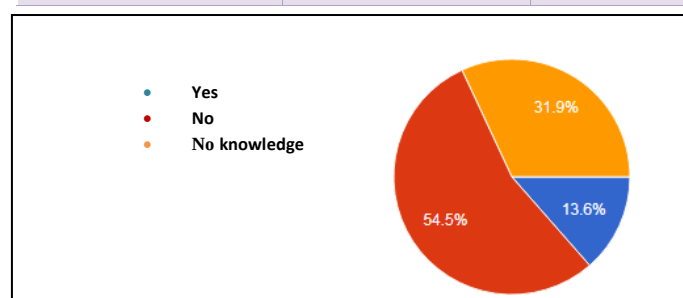


Figure15 : A relative circle representing the opinions of the studied sample about whether these products are healthy or not.

The results showed that most of the sample members stated that these industrial products are unhealthy, and therefore we will provide them with healthy Madeleine.

Table16 : The answer to what is missing in these products according to the sample's opinion

Options	The number	Percentage
Taste	54	8,4%
Food Quality	196	30,6%
Price	32	5%
Confidence in Ingredients	305	47,7 %
Other	53	8,3%
Total	667	100%

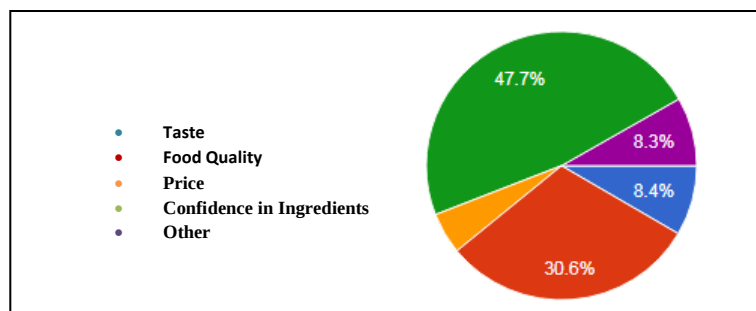


Figure16 : This circle represents the relative results of the opinions of the studied sample regarding what is lacking in these industrial sweets products.

In the opinion of the majority of the sample, these products lack confidence in the ingredients 47,7 %, followed by nutritional quality 30,6%, then taste 8,4%, and a few of them say that they lack price.

Table17 : When choosing a food product for your child, what factors matter most to you

Options	The number	Percentage
Nutritional Value	400	62,8%
Taste	41	6,4%
Attractive Packagin	6	09%
Price	15	2,4 %
Coating Recommendations	151	23,7%
Brand	13	2%
Other	11	1,7%
Total	667	100%

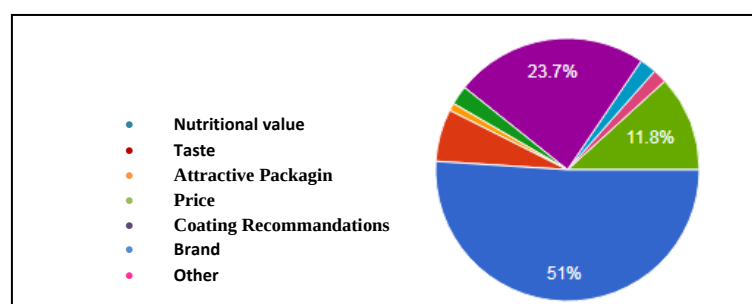


Figure17: A relative circle representing the important factors for parents when choosing a food product for their child, according to the opinion of the sample studied.

Based on the results obtained from the studied sample, most parents are concerned about the nutritional value when testing a food product for their children, and then follow the recommendations of doctors and specialists. This means that our project will be accepted and welcomed by consumers.

Table18 :The extent of parents' interest in providing healthy products for their children

Options	The number	Parentage
Yes, always	377	59,6%
Yes, sometimes	216	34,1%
I don't focus much	35	5,5%
No, I don't care	5	0,8%
Total	667	100%

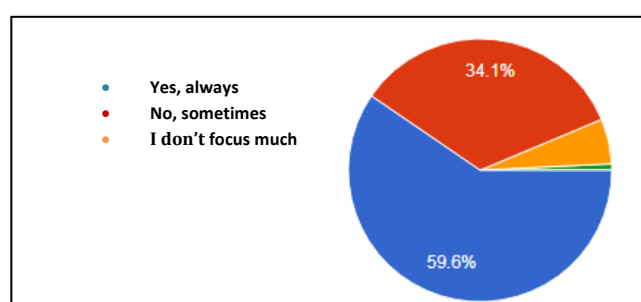


Figure18: A relative circle representing the extent of parents' interest in providing a healthy product for their children.

Most of the results show that parents are always interested in choosing a natural food product for their children, and this is what we will provide for them in our project.

Table19 :Answering the question of people's interest in purchasing the healthy Madeleine product

Options	The number	Parentage
yes	523	82.1%
no	13	2%
maybe	101	15.9%
Total	637	100 %

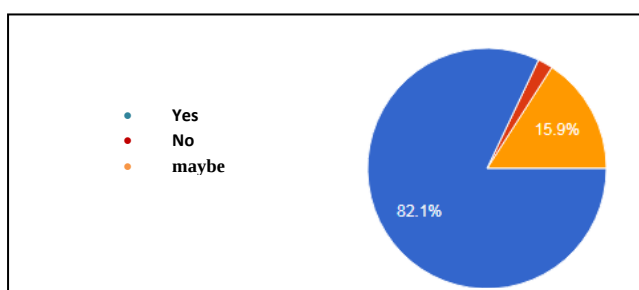


Figure 19:A relative circle representing the percentage of people interested in the healthy madeleine product.

The results showed that 82.1% of participants would be willing to purchase a healthy madeleine, indicating a strong interest in healthy alternatives. A further 15.9% responded maybe, a category that could be won over by product quality and a reasonable price. Only 2% of respondents were unwilling, reflecting strong public acceptance of the concept.

Table20:Answering the question of how much price affects the decision to purchase a product

Options	The number	Parentage
---------	------------	-----------

Price is very important- I will not buy if it is more expensive than normal	184	28.7 %
Price is important but I would buy if the product was actually healthy	361	56.4 %
I don't care much about the price if you are sure of the quality	95	14.8 %
Total	640	100 %



Figure 20 :A relative circle representing the proportion of price influence on a consumer's decision.

The results indicate that consumers are willing to pay a higher price if they are assured of the health benefits, reflecting growing nutritional awareness. However, a significant segment remains price-sensitive, necessitating balanced pricing that highlights product quality without alienating low-income groups.

The fourth Axis:
Production
plan and
organization

IV- The fourth axis: Production plan and organization

IV-1- Production process

The production process of madeleines at our institution goes through several successive stages, as follows:

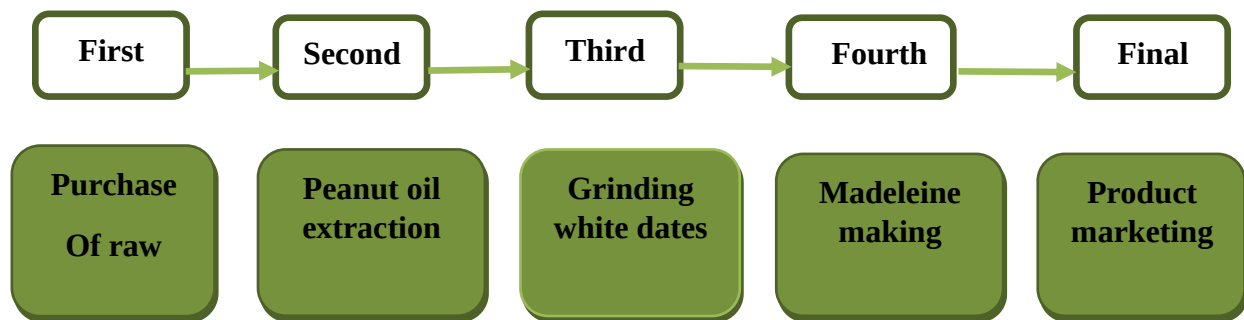


Figure 01: Summary of production stage in our organization.

IV-1-1- First Stage: Obtaining Raw Materials

After receiving these materials, our production team obtains raw materials from carefully selected suppliers. These materials are high-quality peanuts and Deglah Beidha, which are inspected in our laboratory to ensure their safety and that they do not negatively affect the quality of the final product.

IV-1-2- Second Stage: Drying

The Deglah Beidha dates are thoroughly cleaned and then dried in an oven to reduce their high moisture content and prevent mold or bacterial growth.

IV-1-3- Third Stage: Peanut Oil Extraction

The oil extraction process is carried with a chemical solvent using a Soxhlet extractor, then separated and disposed of using a rota-vapor.

IV-1-4 -Milling Stage

The dried dates are ground in high-powered electric mills.

IV-1-5 -fourth stage: Preparing the Madeleines

Mix all the usual ingredients for any madeleine recipe, replacing the glucose syrup with date powder and the oil with peanut oil. Make sure Deglah Beidha powder easily with the liquid ingredients, as

it quickly takes on the consistency of a thick dough. Place the mixture in the madeleine molds and bake at 180°C for 20 minutes.

IV-1-6- Final Product Stage

The final product is manufactured and presented in two different formats: canned for long-term consumption and on-site for quick consumption.

IV-1-7- Packaging Stage

packaging system has been adopted to ensure optimal preservation of product quality, safety during transport and storage, and compliance with health standards. This approach aligns with the expectations of the target consumers.

1. Primary Packaging:

We will pack the madeleines in a plastic drawer, then in a plastic bag, using transparent food-grade film. This material is moisture-resistant, lightweight, and designed to maintain product freshness while ensuring hygienic conditions.

2. Secondary Packaging:

The are placed inside a hygienic cardboard box, suitable for storage and display, and extended shelf-life. Each box contains 6 pieces of madeleine, and a smaller package was prepared containing 2 madeleines using the same packaging system, intended for individual consumption.

The boxes will be packed in specially designed cardboard big boxes for transportation, engineered to protect the product from physical and thermal changes during transit and storage. This ensures that the product reaches the points of sale or the consumer in high quality, while minimizing the rate of returns or damage during distribution.

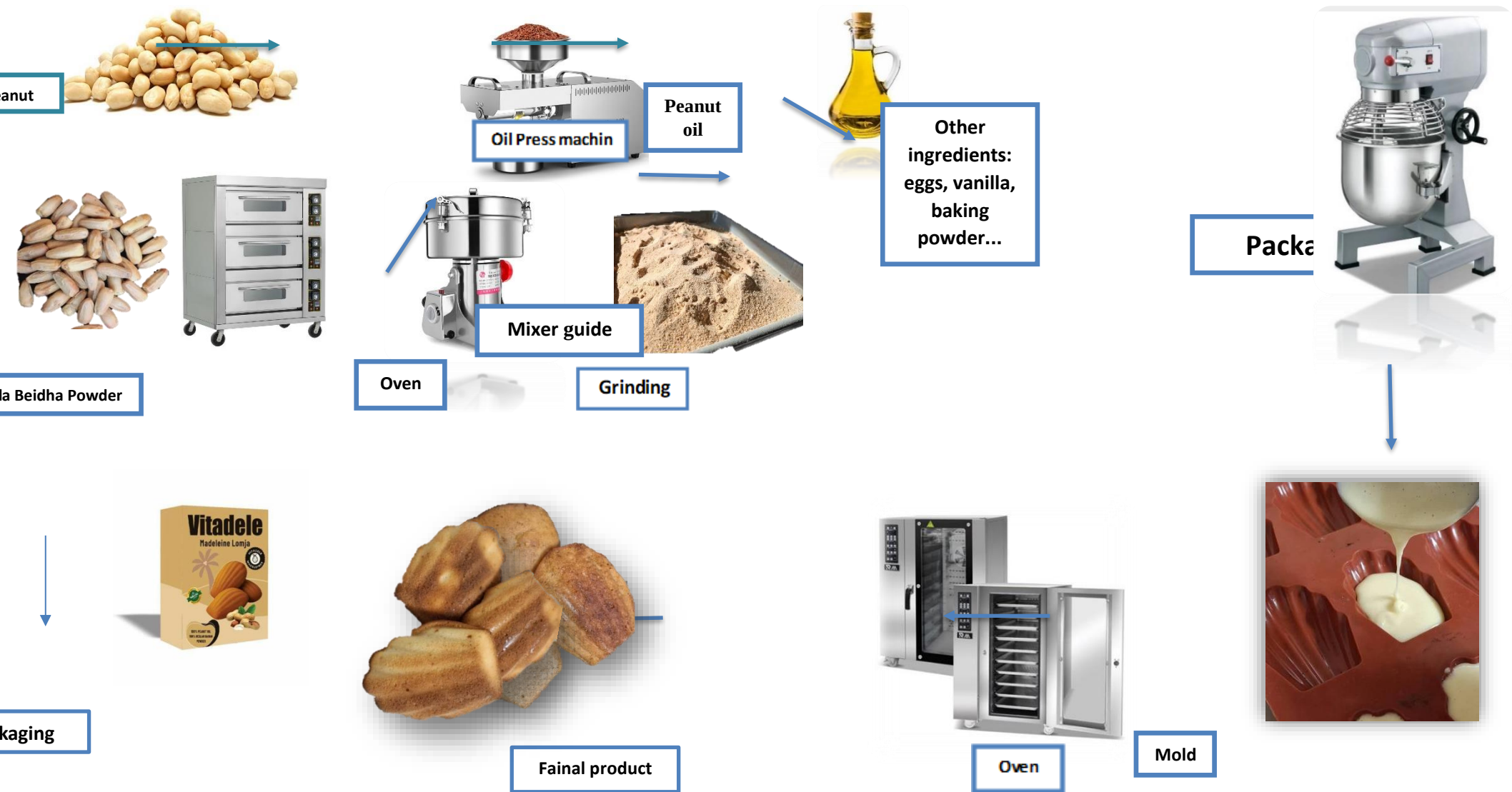


Figure 02: Comprehensive general plan of the production process mechanism

IV-2- Procurement

The procurement process aims to provide the necessary materials (raw materials and equipment) to operate our facility efficiently and sustainably, in specific quantities and types, at the right time, and at the lowest possible cost. This avoids any production and inventory shortages, enabling us to achieve a balance between supply and demand. To this end, we rely on a procurement policy to obtain the materials needed for our production processes. This policy includes:

1-First: Determining Purchasing Requirements

We will follow specific steps to identify the basic materials for our production. We will begin by estimating market demand and calculating the required quantities. We will then select the materials and determine the quality standards. We will then contract with suppliers to secure the materials of the required quality and monitor their quality to ensure they meet specifications. This way, we ensure the availability of the materials needed to produce Madeleine efficiently and with high quality.

2-Second: Evaluating Suppliers

We will evaluate and select reputable and reliable suppliers capable of providing high-quality materials at competitive prices. We begin by defining the required standards, then search for and evaluate potential suppliers, and conduct negotiations. After selecting the appropriate supplier, we will sign the contract and monitor their performance regularly. This ensures cooperation with suppliers who meet our needs efficiently and with high quality.

3-Third: Negotiations and Negotiations

Conduct effective negotiations with suppliers to obtain favorable terms and prices, and achieve a balance between quality, price, and delivery.

4-Fourth: Inventory Management

Effective Inventory Management: To ensure the timely availability of necessary materials while maintaining optimal inventory levels, we will carefully organize inventory operations, monitor orders, and assess future needs to ensure a balance between providing materials and avoiding unnecessary surpluses.

5-Fifth: Cost Control

Cost management will be ensured by comparing available offers and selecting suppliers who combine high quality with reasonable prices. The main suppliers involved in this project include:

- Local farmers for the supply of raw materials.

- A specialized printing house for providing product labels and brand packaging.

The total production cost of “Vitadele Madeleines” was estimated based on local market prices for the raw materials used (such as peanut oil, deglah beidha powder, eggs, flour, etc.), in addition to packaging, energy, and manual labor costs.

Based on these estimates, the product is expected to be competitively priced compared to traditional madeleines, which typically rely on hydrogenated oils and processed sugars such as glucose syrup. This cost balance makes it possible to offer a healthy product at an affordable price, granting it a dual competitive advantage in terms of both quality and cost. This is likely to increase the product’s appeal to a wide range of consumers, particularly children, individuals with diabetes, and those interested in healthy eating habits.

IV-3- Workforce

Our organization's organizational structure provides a basic framework for distributing and defining responsibilities among various departments, with the aim of organizing work and facilitating communication within the organization, in order to achieve our economic and commercial goals.

IV-4 -The main companies

Several stakeholders will contribute to the success of this project, including local suppliers of raw materials such as peanuts and deglah beidha , and food packaging companies that will provide suitable, hygienic packaging, along with distribution and marketing partners to ensure the product reaches. The support provided by the University of El Oued Business Accelerator is pivotal in both organizing and operating the project. Specialized laboratories ensure quality and excellence, thereby enhancing consumer confidence. In addition, our personal commitment and support remain essential to the project's success.

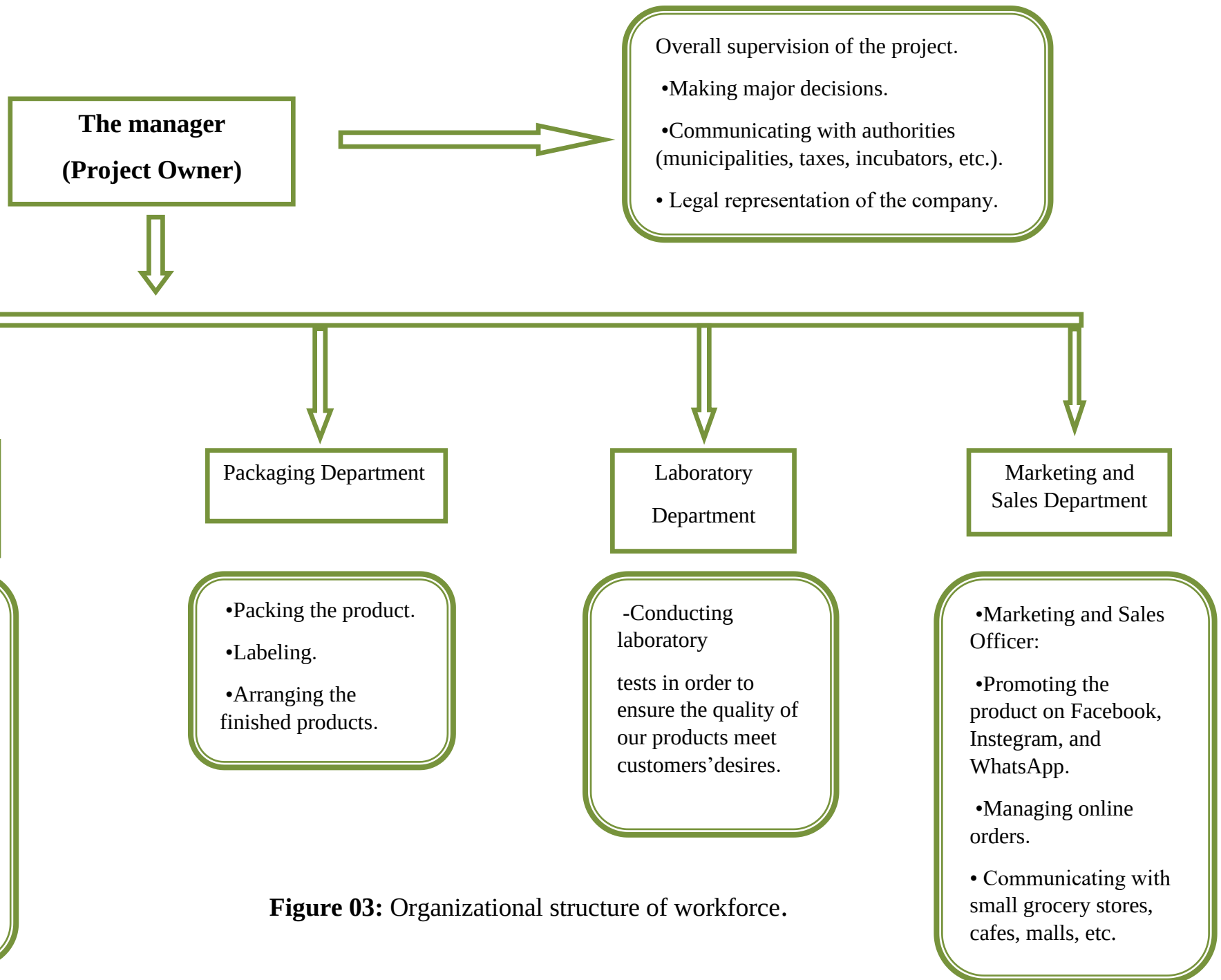
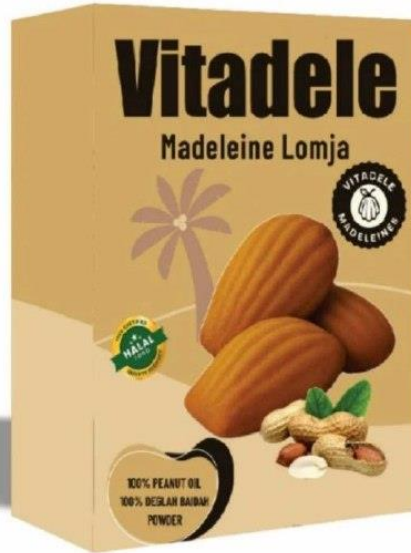


Figure 03: Organizational structure of workforce.

The fifth axis:
The experimental
Prototype



The sixth axis:
Economic
Feasibility study

VI-The sixth axis: Economic Feasibility study

This study aims to evaluate the economic feasibility of a healthy madeleine «Vitadele» production project using peanut oil and deglah beidha powder, by calculating fixed and operating costs and analyzing expected revenues to determine the project's profitability and feasibility

VI-1-Investment costs (fixed)

Table01: Investment costs (fixed)

Basic equipment	Description	the price (DZ)
Oil press machine	For pressing peanuts and extracting their oil	540,000.00
Date pitting machine	For removing the pits of Deglah beidha	70,000.00
Oven for cooking madeleines and drying white dates	gas ovens (each with a 02 (capacity of 10 trays	1,000,000.00
Grinding machine	For transforming Deglah into fine powder	130,000.00
Large dough mixer	liter capacity-40	220,000.00
Packaging equipment	sealing machines 2	10,000.00
Air-conditioned room	air 2 conditioned	220,000.00
Other equipment	Madeleine molds, digital scale, 2 stainless steel work tables	165,000.00
Total	/	2,355,000.00

VI-2-Monthly operating costs

Table02: Salaries

Job title	Number of workers	Monthly salary (DZ)	total monthly salary (DZ)
Sorting, drying, and grinding of date palm (Deglah) and extraction of peanut oil	2	30,000.00	60,000.00
Cooking and baking	1	40,000.00	40,000.00
Cleaning	1	25,000.00	25,000.00
Packaging	3	30,000.00	90,000.00
Supervision and management	1	45,000.00	45,000.00
Total	7	/	260,000.00

Table03: Facilities and services

Item	Monthly cost (DZ)
Electricity	10,000.00
Water	10,000.00
Gas	10,000.00
Factory Rental	50,000.00
Total	80,000.00

Table04: raw materials

Ingredients	Required quantity	Unit price (DZ)	Total (DZ)
Eggs	18720 pieces	15	280,800.00
Vanilla	39 kg	300	11,700.00
White vinegar	18.2 liters	140	2,548.00
White dates	702 kg	180	126,360.00
Peanuts oil	182 liters	1800	327,600.00
Milk	910 liters	100	91,000.00
Flour	780 kg	70	54,600.00
Yeast	46.8 kg	300	14,040.00
Total	/	/	908,648.00

We will pack the madeleines in a plastic drawer, then in a plastic bag, and place them all in a box containing **6** pieces:

- In the case of a box of six madeleines: 5,000 pieces will give us 833 boxes.
- Packing one box costs 34.5 **DZ**.
- Packing and packaging 5,000 pieces costs 28,738.50 **DZ**.
- Total packaging cost: $28,738.50 * 26 = 747,201.00$ **DZ**

VI-3-Cost analysis

Total investment costs: 2,355,000.00 **DZ**.

Total monthly costs:

- **Salaries:** 260,000.00 **DZ**.
- **Utilities and services:** 80,000.00 **DZ**
- **Raw materials:** 908,648.00 **DZ**
- **Packaging and wrapping:** 747,201.00 **DZ**

Total: 4,350,849.00 **DZ**

Factory costs for the first month were estimated at **4,350,849.00 DZ**, assuming 5,000 madeleines were produced daily for **26 days**.

Cost of one box:

- **Salaries:** $(260,000.00 \div 26) \div 833 \approx 12 \text{ DZ}$

- **Utilities and services:** $(80,000.00 \div 26) \div 833 \approx 3.7 \text{ DZ}$

- **Raw materials:** $(908,648.00 \div 26) \div 833 \approx 42 \text{ DZ}$

- **Packaging and wrapping:** $(747,201.00 \div 26) \div 833 \approx 34.5 \text{ DZ}$

Total = 92.2 DZ per box

VI-4-Expected revenues

A pack of 6 for **115 DZ**.

Sales volume: 833 boxes in the day

Production cost:

Madeleines costs: $92.2 \times 833 \times 26 = 1,996,867.60 \text{ DZ}$

Madeleine sales: $115 \times 833 \times 26 = 2,490,670.00 \text{ DZ}$

$2,490,670.00 - 1,996,867.60 = 493,802.40 \text{ DZ}$

revenues: 493,802.40 DZ

VI-5-Feasibility indicators

This section highlights the most relevant financial indicators to evaluate the project's economic viability based on calculated costs and projected revenues.

Break-even point

$310,000.00 \div (115 - 76.64) \approx 8082 \text{ per}$

Payback period:

To calculate approximately when the project covers its initial investment:

Initial investment cost: 2,355,000 **DZ**

Monthly profit: 493,802.40 **DZ**

$2,355,000 / 493,802.40 \approx 4.8 \text{ months}$

VI-6-Utilizing waste

Potential additional income:

Peanut residue: Can be sold as animal feed, sold to farmers as organic fertilizer, or sold as a supplement to bread and biscuits due to its high protein and fiber content (earning between 100 and 200 **DZ** per kg).

Poor quality deghlah kernel residue: Dry and sell as animal feed (40 **DZ** per kg)

-A competitive and health-oriented product

-Local resource availability and low fixed costs

These indicators confirm that the project is financially viable, competitive, and scalable in the region of El Oued.

List of Appendices

The Business Model

 Target audiences -Women (especially mothers). -People with chronic diseases and obesity. -Those interested in healthy nutrition. -Educational and health centers, nurseries, and sports clubs.	 Customer Relationships -Adopting digital marketing techniques through social media. -Direct communication with consumers through free tastings. -Providing customer service (responding to inquiries + delivery). -Continuous motivation through loyalty programs and discounts on large orders.	 Core Value Healthy and Safe Alternative: Using peanut oil instead of butter or hydrogenated oils provides healthy (unsaturated fats) Naturally Sweetened: Deglah Beidah is a natural source of sugar and fiber, reducing reliance on glucose syrup. Free from preservatives or artificial ingredients. Local Value and Cultural Identity: An authentic Algerian product, an alternative to imported products, incorporating ingredients such as Degleh Baidah, connects the product to the local culinary heritage. Supporting Local Farmers: Raw materials from local producers provide a developmental and economic dimension. -Affordable price for quality.	 Main Tasks -Production (preparing white deglah powder, pressing peanut oil, baking, packaging, and storing madeleines). -Research and development of healthy recipes. -Market and competition research and analysis. -Promotion and distribution. - Quality control and compliance with health standards.	 Key Partners -Raw material suppliers (farmers, wholesalers). -Packaging and packaging material suppliers. -Production machinery suppliers and after-sales service providers (spare parts and maintenance). -Printing presses and carton factories. -Distributors and distribution points. -Childcare centers, educational and healthcare institutions. -Business incubators
 Channels -Local points of sale (grocery stores, supermarkets, cafes, etc.) -Online promotion (Facebook, Instagram, etc.) -Direct sales from the factory -Partnerships with educational and healthcare institutions.	 Primary Resources -Machinery and Equipment -Initial Capital -Raw Materials (Daglah, Peanuts, Eggs, Flour, etc.) -Skilled Labor - Branding, Packaging, and Labeling			
 Sources of Income -Selling VITADELE products in various sized cans. -Selling by-products (deglah baidah powder, peanut oil, etc.). -Selling deglah beidah and peanut residues to other animal feed companies.			 Cost Structure -Production equipment and machinery 2,355,000.00 DZ -Operating costs (raw materials, labor wages, rent, electricity, gas, water).1,248,648,00 DZ -Promotion and distribution costs.20,000 DZ -Maintenance and insurance costs. 6,000 DZ -Packaging costs..747,201.00 DZ -Social security contributions and tax fees .5,000 DZ	