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Evaluation of the biological activities of extracts and essential oil of *rosmarinus officinalis*

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أسماء

Abriviation liste

- **Abs**: Absorbance
- **AbsE**: Absorbance of the sample
- **AbsT**: Absorbance of the control
- **ATCC**: American Type Culture Collection
- **Cm**: centimeter
- **DPPH**: 2,2-diphenyl-1-picryl-hydrazyl
- **E. Coli:** Escherichia coli
- **Fe2+**: Ferrous iron
- **Fe3+**: Ferric iron
- **Fecl3**: Iron chloride
- **FRAP**: Ferric-reducing antioxidant power
- **g**: gram
- **H** : time
- **EO**: Essential oil
- **I%**: Percentage of inhibition
- **IC50**: Inhibitory concentration 50
- **mg**: Milligram
- **MHE**: Mass of the essential oil obtained
- **min**: minute
- **ml**: milliliter
- **MPS**: Mass of the treated dry plant
- **nm**: Nanometer
- **PR:** reducing power
- **RHE**: Essential oil yield
- **UV**: ultraviolet
- **°C**: Degree
- **µg**: Microgram
- **µl**: Microliter
- **GC/MS** :coupling of gas chromotography with mass spectrometry
- **HPLC** : high performance liquide phase chromotography

Résumé

Ce travail s'intéresse à la valorisation d'une plante médicinale poussant à l'état spontané dans la région de Bouira , il s'agit de Rosmarinus officinalis, par l'étude de l'activité antimicrobienne, pouvoir antioxydant de ses extraits (aqueux et méthanolique) et de ses huiles essentielles. L'extraction a été effectuée par macération (extrait méthanolique , extrait aqueux) et hydrodistillation (huile essentielle). Après, L'activité antioxydante a été révélé par deux méthodes (piégeage du DPPH et réduction du fer). Ensuite, nous avons évalué l'activité antimicrobienne par la méthode de diffusion des disques. L'extrait méthanolique a présenté le rendement le plus élevé (22,36 %). L'activité anti-oxydante a montré que l'extrait aqueux est le plus puissant par rapport les autre par une IC50 de l'ordre de1.13 ±0,71 µg/ml. L'activité antimicrobienne a été étudiée vis-à-vis de quatre souches bactériennes et une souches fongiques. L'activité antibactérienne de l'huile essentielle était la meilleure comparativement à celle des deux extraits. En outre, l'huile essentielle de Rosmarinus officinalis n'exercé pas une activité antifongique vis-à-vis Candidas albicans . En ce qui concerne les résultats de l'analyse par HPLC et GC-MS les principaux constituants sont l'acide rosemarique, le carnosol, le Pinene ,acide ascorbique , caféin ,rutun ,Terpinen, et d' autre . L'huile de romarin a montré dans le traitement de la chute des cheveux. Les résultats ont montré que l'huile de romarin peut stimuler la croissance des cheveux et réduire leur chute grâce aux composants de l'huile essentielle de romarin.

Mots clés : *Rosmarinus officinalis,* , extrait méthanolique, extrait aqueux ,huille essentielle , antimicrobien,antioxydante , HPLC, GC /MS .

Abstracrt

This work focuses on the valorization of a medicinal plant growing spontaneously in the Bouira region, it is Rosmarinus officinalis, by the study of the activity antimicrobial, antioxidant power of its extracts (aqueous and methanolic) and its essential oils. The extraction was carried out by maceration (methanolic extract, aqueous extract) and hydrodistillation (essential oil). Afterwards, the antioxidant activity was revealed by two methods (DPPH scavenging and iron reduction). Then, we evaluated the antimicrobial activity by the disk diffusion method. The methanolic extract presented the highest yield (22.36%). The antioxidant activity showed that the aqueous extract is the most powerful compared to the others with an IC50 of the order of 1.13 ±0.71 µg/ml. The activity antimicrobial was studied against four bacterial strains and one fungal strain. The antibacterial activity of the essential oil was the best compared to that of the two extracts. In addition, the essential oil of Rosmarinus officinalis does not exert antifungal activity against Candidas albicans. Regarding the results of the analysis by HPLC and GC-MS the main constituents are rosemaric acid, carnosol, Pinene, ascorbic acid, caffeine, rutun, Terpinen, and others. Rosemary oil has in the treatment of hair loss. The results showed that rosemary oil can stimulate hair growth and reduce hair loss thanks to the components of rosemary essential oil.

Key words: *Rosmarinus officinalis*, methanolic extract, aqueous extract, essential oil, antimicrobial, antioxidant, HPLC, GC/MS.

ملخص

يركز هذا العمل على تثمين نبات طبي ينمو تلقائيا بمنطقة البويرة، وهو *Rosmarinus officinalis*، من خلال دراسة النشاط المضاد للميكروبات والقوة المضادة للأكسدة لمستخلصاته (المائية والميثانولية) وزيوته الأساسية. تم إجراء الاستخلاص عن طريق النقع (المستخلص الميثانولي، المستخلص المائي) والتقطير المائي (الزيت العطري). بعد ذلك، تم الكشف عن نشاط مضادات الأكسدة بطريقتين (كسح DPPH وتقليل الحديد). ثم قمنا بتقييم النشاط المضاد للميكروبات بطريقة الانتشار على القرص. قدم المستخلص الميثانولي أعلى إنتاجية (22.36%). أظهر نشاط مضادات الأكسدة أن المستخلص المائي هو الأقوى مقارنة بالمستخلصات الأخرى مع IC50 في حدود 1.13 ± 0.71 ميكروغرام / مل. تمت دراسة النشاط المضاد للميكروبات ضد أربع سلالات بكتيرية وسلالة فطرية واحدة. كان النشاط المضاد للبكتيريا للزيت العطري هو الأفضل مقارنةً بالمستخلصين. بالإضافة إلى ذلك، فإن الزيت العطري لنبات *Rosmarinus officinalis* لا يمارس نشاطًا مضادًا للفطريات ضد المبيضات البيضاء. فيما يتعلق بنتائج التحليل بواسطة HPLC وGC-MS فإن المكونات الرئيسية هي حمض الروزماريك، كارنوسول، بينين، حمض الأسكوربيك، الكافيين، روتون، تيربينين، وغيرها. أظهر زيت إكليل الجبل في علاج تساقط الشعر. وأظهرت النتائج أن زيت إكليل الجبل يمكن أن يحفز نمو الشعر ويقلل من تساقطه بفضل مكونات زيت إكليل الجبل الأساسي.

الكلمات المفتاحية: إكليل الجبل المخزني، المستخلص الميثانولي، المستخلص المائي، الزيت العطري، مضادات الميكروبات، مضادات الأكسدة، HPLC، GC/MS.

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General Introduction

Since ancient times, man has used various resources found in his environment to treat all kinds of diseases. Currently, the World Health Organization (WHO) estimates that approximately 80% of the earth's inhabitants rely on traditional herbal preparations as primary health care.

Currently, research on the benefits of aromatic plants is seeing its development increase, particularly with EOs whose fields of application are numerous in medicine, pharmacy as well as in other fields such as the food industry, chemical industries, etc.

The essential oils of plants from the Lamiaceae families are very Sought after because they generally have interesting biological properties. THE Bioactive effects of essential oils and extracts have largely been shown to be linked to their great wealth of terpene and aromatic compounds whose chemical structures are very diverse **(Merghache *and al.*, 2009).**

As a result, the valorization of natural resources is a concern that is becoming Increasingly important in many countries **(Aboughe Angone *and al.*, 2015)**. Algeria, a country known for its natural resources, has a singularly rich and varied flora. Around 3,000 plant species, 15% of which are endemic and belonging to several botanical families **(Dif *and al.*, 2015).**

Rosmarinus officinalis is one of the most used medicinal plants throughout the world. The essential oil extracts of this plant are widely used in traditional medicine, for centuries against a multitude of ailments. Today, the Rosemary has entered modern medicine. Is of considerable importance in term of its great an important medicinal and aromatic value. This plant belongs to Lamiaceae family. Rosemary is a perennial evergreen herb with fragrant needle like leaves **(Bousbia *and al.*, 2008)** Rosemary herbs have been widely used in the traditional medicine and cosmetics. They are also used as flavoring agents in foods. Rosmarinus officinalis essential oil is also important for its medicinal uses and its powerful antibacterial, cytotoxic, antimutagenic, antioxidant, antiphlogistic and chemopreventive properties **(Pintore *and al.*, 2002).** Rosemary essential oil While some studies indicate that rosemary oil and extract can promote hair growth by improving hair growth blood circulation and reduce hair loss.

Our work is part of a better knowledge of Algerian rosemary *R. officinalis* from the point of view of their chemical composition, by the study of biological activity by the in vitro study of antioxidant and antimicrobial activity.

The first part of this work will be devoted to extraction and GC/MS analysis. essential oils as well as the evaluation of the content of total phenols and flavonoids from R.officinalis extracts, The different extracts were analyzed by HPLCin order to compare their

chromatographic profiles and to obtain information on the composition of these alcoholic, aqueous flavonoid extracts in comparison with the different standards collected from the regions of Bouira.

In the second part the different extracts thus characterized will be evaluated from the point of view of Seen from their antioxidant and antimicrobial activities.

Chapter I: Rosmarinus offcinalis L

I- Rosmarinus offcinalis

I-1- Definition

Rosemary, which gives the name sea rose, comes simply from the fact that it grows spontaneously by the sea. It is a shrub from 50 cm to 1 meter and more, always green, very aromatic, very branchy, very leafy. The flowers are pale blue or whitish. Its bark peels off the oldest branches and its smell is extremely fragrant and tenacious **(Makhloufi, 2009).** Flowering begins in February (or January sometimes) and continues until April-May **(Mostefai, 2012).**

According to **(Mathias, 2008)** *Rosemary* is part of the Lamiaceae family under the scientific name *Rosmarinus officinalis*, the period of its flowering is during January and May. Its pollen is characterized by grayish white color.

The Algerian flora contains an unlimited number of plants with therapeutic virtues. *Rosmarinus Officinalis* (*rosemary*) is a plant used in various fields such as traditional medicine and herbal medicine **(Ayadi *and al.*, 2011).**

(Personal photo, 2024).

(Maaoui, 2014).

Figure (01): *Rosmrinus officinalis L.*

I-2- Systematic description of *Rosmarinus officinalis* L

I-2-1- Lamiaceae family

The Lamiaceae or Labiaceae family, also called Labiaceae, is considered one of the main Mediterranean species families **(Labiod, 2016).**

This family of dicotyledonous angiosperm plants includes approximately 258 genera and 6970 species **(Bottineau, 2010).** The Lamiaceae family is very important in the flora of Algeria, but certain genera are difficult to determine due to the extreme variability of the species **(Bousbia and Souaci, 2021).**

These species are often plants, generally aromatic, rich in essential oil, hence their economic and medicinal interest **(Belloul and Chouiref, 2016).**

I-2-2- Nomenclature of Rosmarinus officinalis L

Rosemary takes its name from the Latin *Rosmarinus*, which means dew of the sea, this name could be applied to the perfume of the plant, to the color of its flower. The name sea rose simply comes from the fact that it grows spontaneously at the edge of the sea, or even its predilection for the coastline. The specific epithet "*officinalis*" recalls that *Rosemary* is a medicinal plant **(Lagsier and Nadir, 2020).**

Table(01): Vernacular names of *Romarinus officinalis* L.

Vernacular name in Arabic	Eklil, Klil, Hatssalouban, Hassalban, Helhal, Yazir	(Aouad and Belayachi, 2019)
Vernacular name in French	Incense, crown herb, *rosemary, rosemary officinal,* Marine rose,, enprovençal, *Romania* or	(Chibah and Labandji, 2017) and (Bouadjemi, 2018).
Vernacular name in English	rosemary, old man moorwort	(Mansouri and Messabhia, 2018). (Dominique *and coll.*, 2008).
Vernacular name in Germany	rosemary, weihrauchkrait, bodekrait	(Mansouri and Messabhia, 2018).
Vernacular names	Klil, Hassalhan , Iazir	(Mansouri and Messabhia, 2018).
Regional appellations in Algeria	Région de l'Est :Eklil Région de l'Ouest : Helhal Région du Centre :Yazir.	(Belkhiri, 2015) and (Bouadjemi, 2018).
Vernacular name in Berber	Azir	(Aafi, 2013).

I-2-3- Classification of *Rosmarinus officinalis L*

The table summarizes the scientific classification of *Rosmarinus officinalis*.

Table(02) : Classification of *Rosmarinus officinalis L*(**Begum *and all* .,2013)**

Kingdom	Plantae
Sub kingdom	Tracheobionta
Super division	Spermatophyta
Division	Magnoliophyta
Class	Magnoliopsida
Sub class	Asteridae
Order	Lamiales
Family	Lamiaceae
Genus	Rosemarinus L
Species	Officinalis
Binomial nomenclature	Rosemarinus officinalis L.

I-2-4- Origin of Rosmarinus officinalis L.

Rosemary is a plant of mediterranean origin, from spain to the balkans and into north africa .Species of reputed plio-quaternary origin ,Native to the mediterranean region **(Hamidpour.R and al, 2017).**

I-3- Botanical description

Rosmarinus officinalis belongs to the botanical family Lamiaceae within the genus *Rosmarinus.* It is an evergreen shrub measuring 0.5 to 2 m **(Chafai *and all* ., 2014).**

(Ouibrahim, 2015).

(Personal photo, 2024

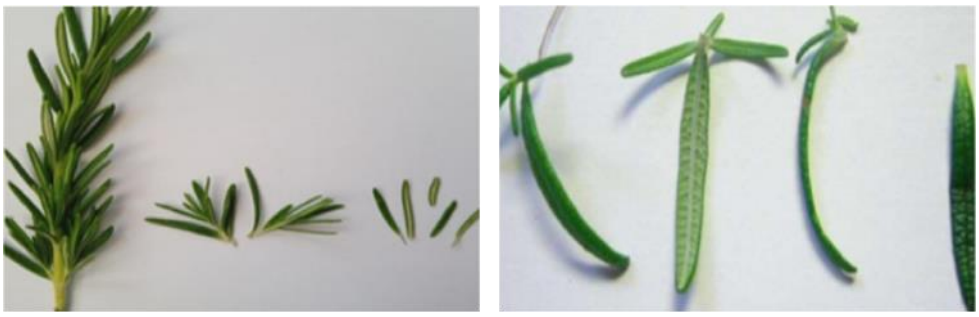
Figure(02): Aspect morphologique du *Rosmarinus officinalis L.*

- **Stem**: Shrub or sub-shrub, branch of 0.5 to 2 meters this stem is tortuous, angular and fragile. The bark is linear with an axillary cyme more or less simulating ears of corn. **(Abdessultane, 2017).**

(personal photo, 2024).

Figure (03): Main stem and flowering foliage branch of *Rosmarinus officinalis*

- **The leaves:** Linear, embossed, leaves leathery, sessile, opposite, rigid shiny with folded edges greenish above more or less hispid whitish below 18 to 50 x 1.5 to 3mm **(Mostefai, 2012).**



(Personal photo 2024). (Academic, 2000-2014).

Figure (04): *Rosmarinus officinalis* leaf

- **The flowers:** purplish blue, visible from January to May, are grouped in a cluster at the end of the branches **(Benzineb, 2019)**.

(Personal photo 2024). (Valter Jacinto ,2015)

Figure (05): The flower of *Rosmarinus officinalis L.*

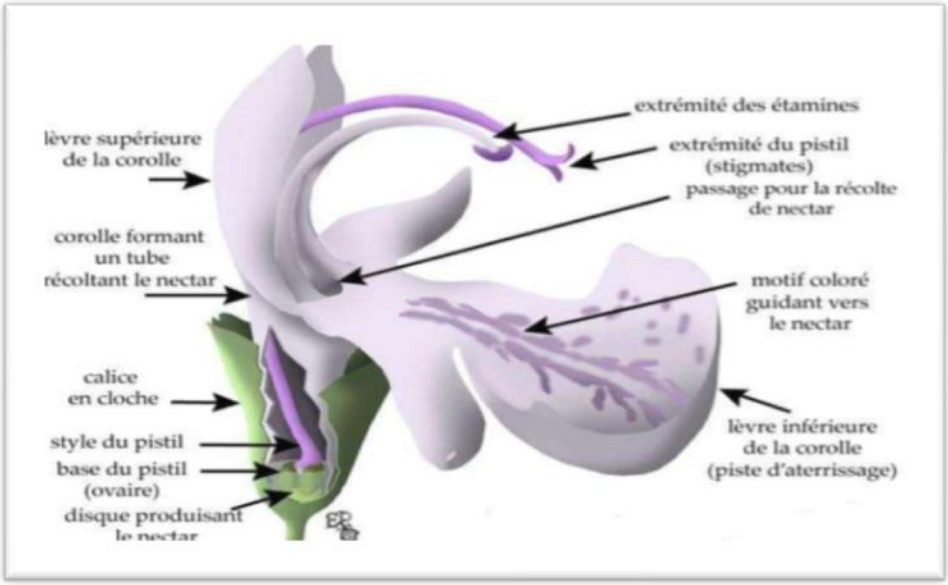


Figure (06): the organization of the flower *of Rosmarinus officinalis* L. **(ullmann, 2005).**

- The fruit, ovoid: is surrounded by a persistent, dry calyx and is made up of four achenes (Tetrakene). It attracts insects (Entomophiles) to ensure pollination (Entomogam) **(Boumadjen and Kimouche, 2018).**

(Valter Jacinto, 2015).

Figure(07): Fruit of *Rosmarinus officinalis*

- **Root** : *Rosmarinus officinalis* has a dense and deep root system which allows it to draw water from deep during periods of drought **(Margot, 2017)**, the root of *Rosmarunis officinalis* is deep and pivoting **(Bousbia and Souaci, 2021).**

(Personal photo 2024).

(paprikaetchocolat.wordpress.com)

Figure(08): the root of *Rosmarinus officinalis* L.

- **Reproduction:** can be done sexually (seed) and asexually (cuttings and splitting of tufts). Its specific modes of dissemination are: gravity, wind, water, animals (mammals, birds, insects, etc.) and humans **(Chafai *and al*., 2014).**

I-4- Distribution

Rosemary grows spontaneously in scrubland, light forests, scrubland, arid and limestone hills **(Bettahar and Chekalil, 2020).** *Rosemary* is grown in a sunny location, in limestone and well-drained soil **(Aissaoui, 2019)**, and dry and arid places, especially near the coast **(Ezziat**, **2013)**. It can grow even on land not suitable for agricultural exploitation, so it has few demands on the soil. It has a preference for clayey or sandy soils, being located in dry, warm places (this is how it produces the most essential oils and gives off the most powerful scents) **(Marion, 2017)**. It is cultivated from early spring until summer **(Aissaoui, 2019).**

I-4-1- In the world

Rosemary is found in all parts of Europe, particularly around the Mediterranean **(Abdessultane, 2017).**Present, it is widely cultivated in spain,morocco,tunisia France, algeria, Portugal and china and, to a limited extent, in india in the nilgiris and bangalore**.***Rosemary* grows spontaneously in southern Europe **(Belbey, 2014).**It is grown all over the world from seedlings or cuttings in spring. It appreciates warm climates (**Benikhelf, 2014).**

I-4-2- In Alegria

In Alegria, *Rosemary* is one of seven plant species **(Soufit and Bennaceur, 2014),** It is anindigenous plant growing spontaneously throughout Alegria **(Ouibrahim, 2015).**where ithas spread widely and covers more than 70,000 ha of the national territory **(Aouati, 2016).**isone of the most popular plants in Algeria since it is found in all gardens and parks on fragrant borders **(Berkane, 2015).**

Varieties *Rosmarinus officinalis L.* : There are more than 150 varieties of *Rosemary*. They are differentiated by their maximum size (from around ten centimeters to 2 meters), their posture (vertical or creeping), the color of their flowers (purple, blue, white, pink) and their leaves, their hardiness (Tab 03) **(BOULEZAZEN, 2017).**

Table(03).: Varieties of *Rosmarinus officinalis* L.

Variety	Name	Features
Rosmarinus officinalis Alba ouAlbus	*Rosemary* with white flowers	White flowers and buds
Rosmarinus officinalis Arp	Rosemary "Arp	Tolerates the cold particularly well (zones 6 to 10). Its leaves have a Lemon smell (Patricia Lanza).
Rosmarinus officinalis Athens Blue Spire	*Rosemary* "Athens Blue Spire"	Dense foliage, powerful aroma (Rush Creek).
Rosmarinus officinalis Barbeque	*Rosemary* “Barbeque”	Very straight stems, suitable for use as skewers (Rush Creek).
Rosmarinus officinalis Bennenden Blue	*Rosemary* "Bennenden Blue"	Large sky-blue flowers, narrow, dark leaves (Patricia Lanza).
Rosmarinus officinalis Blaulippe	*Rosemary* “Blaulippe”	Compact bush, blue flowers tending to purple. Sensitive to cold.

Rosmarinus officinalis Blue Lagoon	*Rosemary* "Blue Lagoon"	Compact bush. Its flowering covers it with small blue flowers.
Rosmarinusofficinalis Corsican Blue	*Rosemary* “Corsican Blue”	Crawling. Deep blue flowers.
Rosmarinus officinalis Fota Blue	*Rosemary* “Fota Blue”	Deep dark blue flowers, dark green foliage
Rosmarinus officinalis Gorizia	*Rosemary* “Gorizia”	Large leaves and large blue flowers. Slightly spicy flavor reminiscent of ginger (Rush Creek).
Rosmarinus officinalis Haifa	*Rosemary* “Haifa”	Crawling. Small and fragile, suitable for indoor pot cultivation
Rosmarinus officinalis Jackmann's Blue	*Rosemary* "Jackmann's Blue"	Sky blue flowers, hanging down
Rosmarinus officinalis Miss	*Rosemary* "Miss Jessop's Upright	*Rosemary* "Miss Jessopp's Upright" Jessopp's Upright Vertical Growth. Variety used as a hedge.
Rosmarinus officinalis Pinkie	Rosemary “Pinkie”	Pink flowers, short, dull leaves (Patricia Lanza)
Rosmarinus officinalis Prostratus	*Rosemary* “Prostratus”	Shiny leaves. Grows spreading, suitable for topiaries (Rush Creek).
Shiny leaves. Grows spreading, suitable for topiaries (Rush Creek).	Rosemary “Roseus”	Pink flowers (Patricia Lanza).
Rosmarinus officinalis Severn Sea	*Rosemary* “Severn Sea”	The branches are drooping. Blue flowers tending towards purple (Patricia Lanza).
Rosmarinus officinalis Sudbury Blue	Rosemary "Sudbury Blue	Blue-green leaves, blue flowers (Patricia Lanza).
Rosmarinus officinalis	*Rosemary* “Tarentinus”	Bushy. Pale blue to purple

Tarentinus		flowers
Rosmarinus officinalis Tuscan Blue	*Rosemary* "Tuscan Blue"	Fast growing, can reach 2 meters in good conditions. Dark blue flowers, dark blue-green, shiny leaves. Appreciated aroma for cooking (Patricia Lanza).
Rosmarinus officinalis Lavandulaceus	*Rosemary* "Lavandulaceus"	Small creeping plant, purple flowers.

I-5- Uses of *Rosmarinus officinalis*

Rosemary has been used in different areas and different ways

I-5-1- Therapeutic

Rosemary is traditionally used for the prevention and treatment of colds, rheumatism, muscle and joint pain **(Calvo *and al*., 2011; Zhang *and al*, 2014),** it is therefore used as an effective diuretic and mood stabilizer **(Haloui *and al*., 2000).** as well as for its antiseptic properties **(Juhas *and al*., 2009).** Rosemary has also been shown to decrease blood sugar levels in several in vivo studies **(Tu *and al*., 2013).** It calms spasms of digestive origin through its spasmolytic action on the intestines and stomach **(Naggar and Iharchine, 2015).** Additionally, rosemary essential oils and extracts obtained from the flowers and leaves are used for minor wounds, rashes, circulation problems **(WHO, 2006; Ulbricht *and al*., 2010 and Begum *and al*., 2013)** and skin care **(Hamedo and Abdelmigid, 2009).**

Rosemary is also used for symptoms such as bad breath, loss of voice, cough and loss of appetite **(Fery-Hue, 1997).** it also lowers blood pressure and cholesterol. Many reports have also highlighted its importance in the treatment of depression, Parkinson's disease, and Alzheimer's disease **(Upadhyay *and al*., 2021).**

In 2019, the British Pharmacopoeia also indicated the use of the twigs and leaves for flatulent dyspepsia of psychogenic origin, as well as headaches,migraines or hypertension and depression **(The British Pharmacopoeia, 2019).** Doses of rosemary leaves for dyspepsia (indigestion), high blood pressure and rheumatism (chronic joint pain) of 4 to 6 g per day have been confirmed to be effective without contraindication. **(American Botanical Council, 2020).** Topically, *rosemary* essential oils are blended in aromatherapy for myalgia (muscle pain), sciatica (sciatic nerve pain), and intercostal neuralgia (pain in the intervening nerves)

(Sayorwan *and al.,* 2013). The oil Rosemary is also considered an abortifacient and should not be used for medicinal purposes during pregnancy **(Elizabeth, 2021).**

Rosemary is cited in Islamic medicine as being good for headaches, abscesses, scorpion stings and epilepsy and being able to expel pus from ulcers **(Al-Herawi, 1859).**

I-5-2- Cosmetics

Since ancient times, Egyptians used creams and oils made from *rosemary* and other plants to protect themselves from the high temperatures and heat of the desert **(Calixto, 2005).**Today, *rosemary* derivatives are used in the formulation of essential oils, *rosemary* alcohol, gels, as well as in the industry of shampoos, soaps, cleansing milk, deodorants, anti-wrinkle creams, aftershave lotions, facial moisturizers, eye creams, etc. **(Andrade *and al.,* 2018).** *Rosemary* essential oils are also used in perfumery **(Naggar and Iharchine, 2015).**

I-5-3- Food

Rosemary is widely used in the food industry as a preservative and antioxidant, for the preservation of meats and fats **(Mostefai *and al.,* 2015).** Its strong flavor can help mask the unpleasant odor and taste of lamb and poultry meats, as well as meats that have suffered micro-soft and microbial spoilage.It is traditionally added to meat dishes either as part of the stuffing or with other strong aromatic herbs or spices **(Northcote, 1903; Vehling, 2020).**

Additionally, milk obtained from goats fed *rosemary* by-products was found to be healthier and with greater technological suitability for cheese making **(Boutoial *and al.,* 2013).**

I-5-4- Hair

Rosemary extract is known for its ability to stimulate hair follicles, which can promote hair growth. When applied to the scalp, rosemary oil increases circulation and transports oxygen and nutrients to the hair follicle. This stimulation of the follicles can help strengthen existing hair and promote the growth of new hair fibers. Studies have shown that rosemary oil can effectively promote hair growth, making it a popular choice for those looking to improve the health and thickness of their hair.**(Rutuja *and al,* 2023).**

- Stimulates hair follicles: Rosemary extract has been shown to increase circulation to the scalp, which stimulates hair follicles and promotes hair growth.
- Improves Scalp Health: The anti-inflammatory and antibacterial properties of rosemary oil help maintain a healthy scalp, which is essential for optimal hair growth.

- Improves hair quality: Rosemary oil can strengthen the hair shaft, making it less sensitive and improving overall hair quality.
- Prevention of dandruff: Rosemary oil creates an ideal environment for hair growth by removing dandruff and keeping the scalp clean **(Panah *and al*., 2015).** Improves the health of the scalp Using rosemary extract for hair not only stimulates hair follicles and promotes hair growth, but also improves the health of the scalp. The anti-inflammatory and antioxidant properties of rosemary oil help reduce the inflammation and irritation of the scalp, making it beneficial for people with dandruff. In addition, rosemary extract has been linked to potential stress reduction, which may help prevent premature graying of hair. If you want to add rosemary oil to your hair care routine, focus on applying it directly to the scalp, give it time to work, and make sure you're using pure rosemary oil with no added fragrance **(Rutuja *and al*., 2023)**.

Studies carried out with hydroalcoholic extracts of rosemary showed a significant increase in hair growth after the sixteenth day of treatment **(Murata *and al*., 2013).**

Chapter II: essentielle oil

Essential oils

I-1- General

Essential oils are products of generally complex composition **(Goetz and Ghedira, 2012).** organically synthesized as secondary metabolites by odorous, so-called aromatic, plants. These plants are characterized by the presence of essential oil secreting structures in almost all their organs (flowers, seeds, roots, leaves, fruits, etc.). Essential oils are mainly made up of two groups of distinct odorous compounds depending on the metabolic pathway taken. Essential oils do not contain fatty substances like vegetable oils **(Bouhdid *and al,* 2012).**

Generally, the majority compounds determine the chemotype (orchemotype) at the origin ofthe biological properties of the essential oils of the plant **(Bakkali *and al.,* 2008).** Essential oils are the most important bioactive substances in medicinal plants by possessing good antimicrobial activity. These substances of plant origin can replace treatments with antibiotics and disinfection using antiseptics **(Benbelaïd *and al.,* 2014).**The components of essential oils can be divided into three large groups:

- Terpenes: monoterpenes and sesquiterpenes including oxidized and hydrocarbon forms.
- Aromatic compounds, e.g.: cinnamic alcohol, coumarin, etc.
- Other very diverse compounds (acids, alcohols, aldehydes, esters, etc.) **(Bourrain, 2013).**

I-2- Definition

Essential oils are volatile substances, liquid at room temperature, hydrophobic in nature, rarely and strongly colored. They have a high refractive index, poorly miscible with water and soluble in organic solvents **(Saihi, 2011).** they are defined as being products of fairly complex chemical composition containing the volatile principles contained in plants and more or less modified during preparation. These oils are both fragrances and natural remedies. They must be used in very low doses, because their active ingredients are hyper concentrated **(Khebri, 2011).**

According to the French Standardization Association "AFNOR" in 1987, an essential oil is defined by: "A product obtained from a vegetable raw material, either by steam distillation, or by mechanical processes from from the epicarp of Citrus, or by dry distillation. The essential oil is then separated from the aqueous phase by physical processes. **(Slougui *and al.,* 2017).** "This definition seems restrictive because it excludes many extraction

processes widely used in the pharmaceutical, cosmetic and food industry markets **(Budavari, *and al*., 2001).**

I-3- Classification

According to the specific power on microbial germs and thanks to the aromatic index obtained by aromatograms, essential oils are classified into groups.

- Major oils
- Medium oils
- Field oils **(Guermit and Rhaim, 2019)**

I-4- Conservation of essential oils

There are specific standards on the packaging, packaging and storage of essential oils (AFNOR NF T 75-001,2006 standard) as well as on the marking of containers containing HES (standard NF 75-002,2006). The conservation of essential oils requires compulsory respect for certain rules **(Echchaou, 2018)** and **(Bourahla *and al*., 2020)** namely:

- Essential oils can be kept well provided that you do not expose them to light, which is why it is recommended to store them in aluminum or tinted glass bottles (brown, green, or blue) and keep them The shelter of light at an ambient temperature up to twenty degrees.
- They must be held away from heat sources.The air space in a jar promotes their oxidation, that is why we prefer several small containers during traffic jams and purchase.
- It is necessary to close the bottles after use, because the essential oils are volatile, therefore they evaporate in the atmosphere and gradually lose their properties and their aroma.
- The bottles should be stored in a vertical position, because in the horizontal position there is a risk that the cap will be attacked by the oil (essential oils have a corrosive action on the plastic).

I-5- Essential oil extraction technique

Various processes are currently used for the extraction of aromatic products from plants. According to the technique used, the extraction of products makes it possible to obtain essential oils, ointments, concretes, absolute, retinoids or infusions **(Mehani, 2015).**

I-5-1- Extraction by cold expression

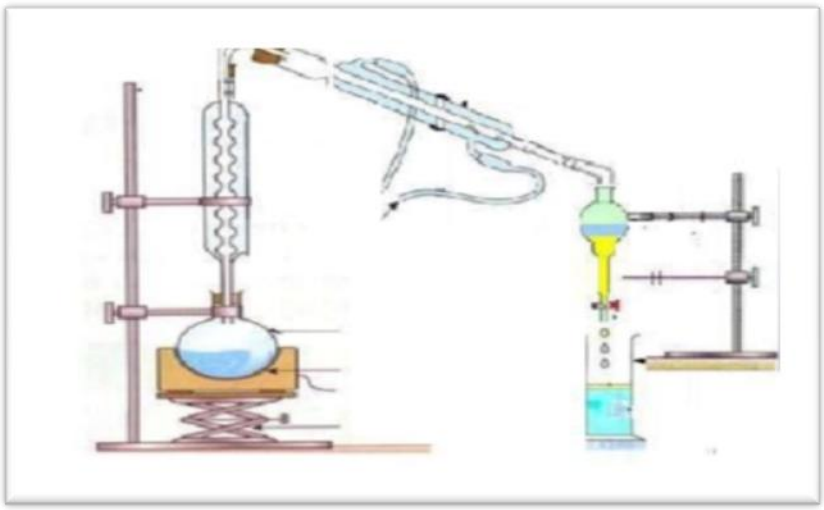
Cold mechanical expression is an extraction process used to recover EO from citrus fruits. This method therefore consists of mechanically breaking the schizolyzigenic secretory pockets present in the fresh pericarps (or zest) of Citrus fruits by exerting strong pressure using a hydraulic press over the entire surface of the fruit. The essences contained in the bags will be released and then they will be harvested by density difference or centrifugation **(Garnier, 2020).** The mechanization and industrialization of the cold expression technique only took place at the beginning of the 20th century, in order to reduce production costs and improve yields to meet the increase in demand. **(Boukhatem., 2019).**

I-5-2- Extraction by distillation

I-5-2-1- Extraction by Hydrodistillation

This is the most commonly used method for the extraction of EO. It is considered to be the simplest and the oldest used **(NAAB and HADIBI, 2018).**The process is to immerse the plant material in a container filled with an adequate quantity of water. The whole is then brought to a boil. Heat allows the bursting of vegetable cells and the release of the fragrant molecules contained therein. He forms with water vapor, an azéotropic mixture.

Then, the vapors are condensed by means of a refrigerant. In another collection container, essential oil separates from water by difference in density. HE is lighter than water, it flies over the hydrolysat. However, hydro distillation has limits. Indeed, a prolonged and too powerful heating generates the degradation of certain aromatic molecules. Laboratory, the system equipped with a cohobe generally used for the extraction of essential oils is the Clevenger **(Yaacoub Ettlidjane, 2018).**



Figure(09) : Hydrodistillation extraction setup **(Mehani, 2015)**

I-5-2-2- Hydro diffusion

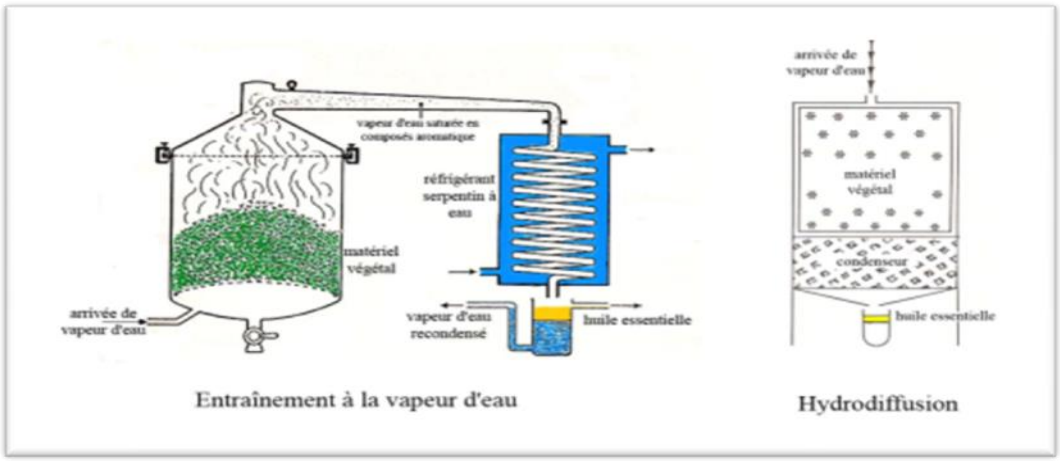
Hydro diffusion is a top-down co-distillation. In this process, the plant is placed in a mesh metal parallelepiped. We therefore subject the plant to a pulse of water vapor, saturated and humid, but never overheated from top to bottom. The shape of the equipment allows for better load distribution. The water vapor carries with it all the volatile substances (figure 09). The essential oil is collected using a collector which allows for equilibrium with atmospheric pressure. We can also specify that there is a cohobation process which returns all the water which is separated from the oils to the boiler (figure10) (**Bousbia, 2011).**

The advantage of this method is that it is faster and therefore less damaging to the volatile compounds, and not to bring plant material and water into contact. Moreover,hydrodiffusion allows energy savings due to the reduction in the duration of the distillation and therefore the reduction of steam consumption **(El Haib, 2011).**

I-5-2-3- Steam training

This is the most common way to extract volatile molecules from AMPs. The plant material is not in contact with the water, but the water vapor produced by a boiler is injected and passes through the plant material from bottom to top **(Herzi, 2013).**

During the passage of the steam through the material, the cells burst and release the essential oil which is vaporized under the action of heat to form a “water + essential oil” mixture. The mixture is then conveyed to the condenser and the essencer before being separated into an aqueous phase and an organic phase: the essential oil. The absence of direct contact between water and plant matter, then between water and aromatic molecules, avoids certain hydrolysis or degradation phenomena that could harm the quality of the oil (figure10**)(El Haib, 2011).**

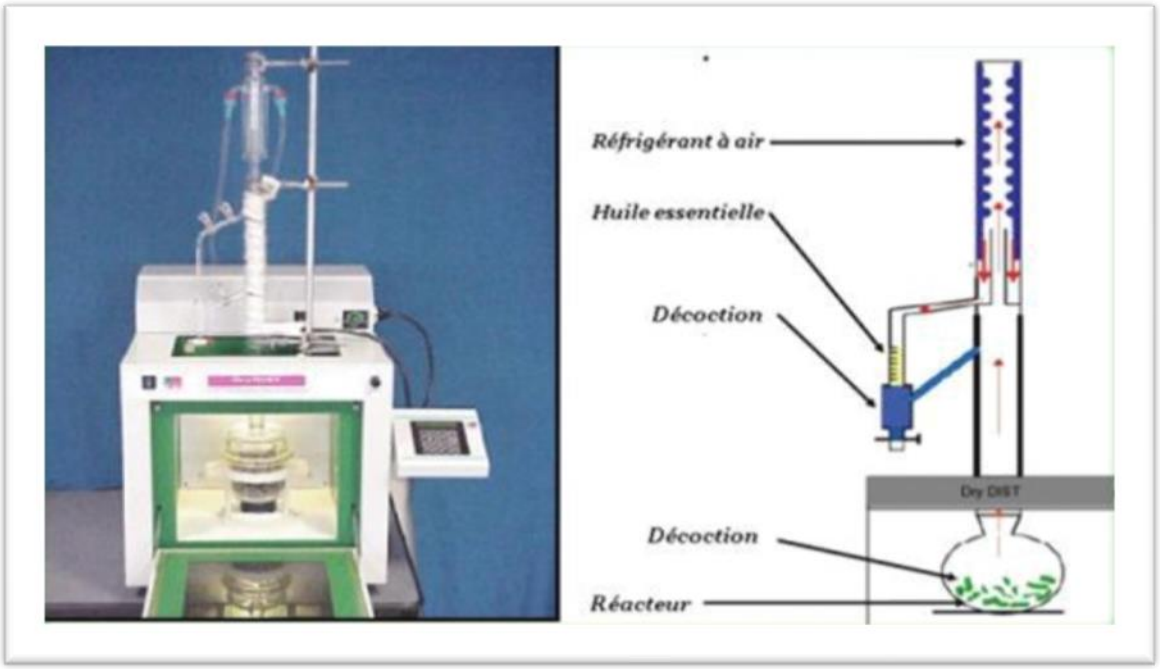


Figure(10): Steam entrainment and hydro diffusion **(lucchesi, 2005).**

I-5-3- Microwave Extraction

Microwave-assisted extraction techniques have been used to extract major components from biological and geological environmental matrices, also to isolate bioactive compounds from plants **(Chelghama, 2021).**

In this process, the plant matrix is heated by micro -waves in a closed enclosure in which the pressure is reduced sequentially. The volatile compounds are carried away by the water vapor formed from the plant's own water. They are then recovered using conventional condensation, cooling and decantationprocesses. This process savesconsiderable time (extraction time divided by 5 to 10) and energy (lower temperature). The method is presented in (figure 11) (**Piochon, 2008).**



Figure(11): Microwave-assisted extraction **(Keraifi and Boualam, 2021).**

I-5-4- Maceration

This technique, also known as hot enfleurage, is one of the most ancient methods used to preserve the scents of plants. Extraction is carried out by immersing freshly picked and constantly renewed flowers in a tank of hot fats until saturation is reached. Absolute alcohol exhaustion is generally applied to this fat **(Manceur, 2015).**

mixture marinates in this way for a few days at 60°C, the flowers coming one after the other gradually. Subsequently, the ointment obtained undergoes filtration in order to eliminate all animal matter. And in the same way as for cold enfleurage, the volatile substances receive an alcohol enema in order to completely extract the desired EO. We then obtain an absolute essence **(Laetitia, 2015).**

I-5-5- Extraction by volatile organic solvent

This technique is most practiced with hydro distillation. It consists of exhausting the raw material of its odorous constituents by means of a solvent, then removing this from the extract by evaporation under vacuum. There are two particular cases, hydrosols (solvent extraction in the presence of water) and alcoholates (extraction with diluted ethanol) **(Abraham, 2006).**

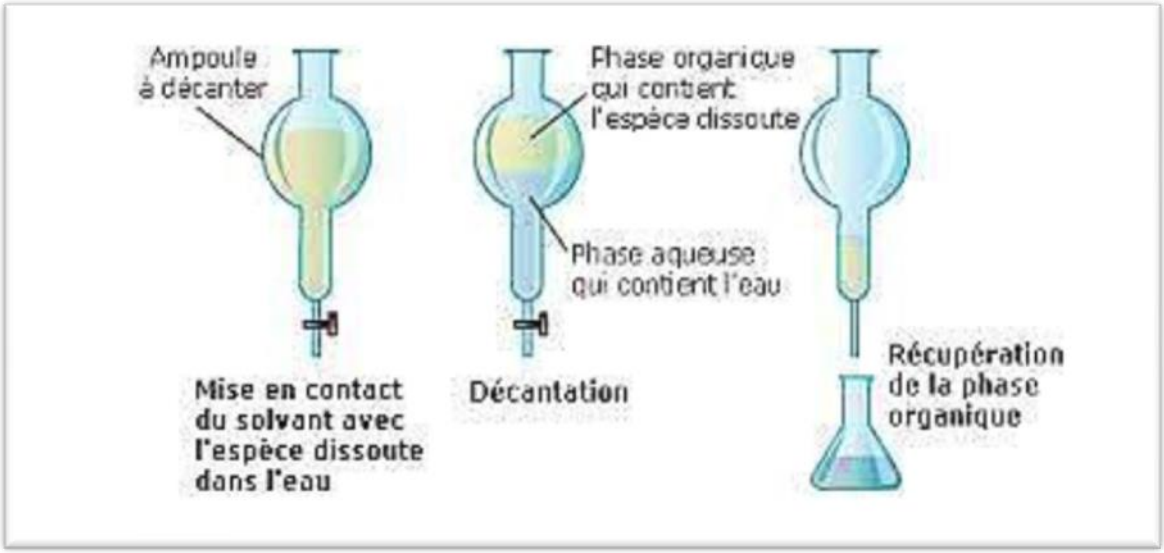
The solvent is then evaporated to give a paste called concrete which contains aromatic compounds, waxes and oily compounds from the plant. At this stage, concrete cannot be used

in perfumery. The waxes present in their composition make the solution cloudy and therefore poorly soluble in the perfume base (figure 12) **(Mnayer, 2014).**

The choice of solvent depends on numerous technical and economic parameters, in particular:

- selectivity (solvent power),
- the boiling temperature (thermal stability of the constituents),
- miscibility in water
- The ease of recycling,
- handling safety: the solvents chosen will, to the extent possible,

possible, non-toxic for both the handler and the consumer **(Abraham,2006).**



Figure(12) : Principe de l'extraction par un solvant organique **(Chorfi and Sid, 2022).**

I-5-6- Extraction by supercritical gases

The originality of the supercritical fluid extraction technique, called SFE, comes from the use of solvents in their supercritical state, that is to say in temperature and pressure conditions where the solvent is in a state intermediate to the liquid and gas phases and presents different physicochemical properties, in particular an increased solvation power. If, in practice, many solvents can be used, 90% of SFEs are carried out with carbon dioxide (CO_2), mainly for practical reasons (figure 13) (**Boukhatem *and al.*, 2019).** This technique has many advantages: supercritical CO2 is an ideal solvent since it is natural, chemically inert, non-flammable, non-toxic, selective, easily available and inexpensive. In addition, it is easily removed from the extract without leaving residue **(Piochon, 2008).**

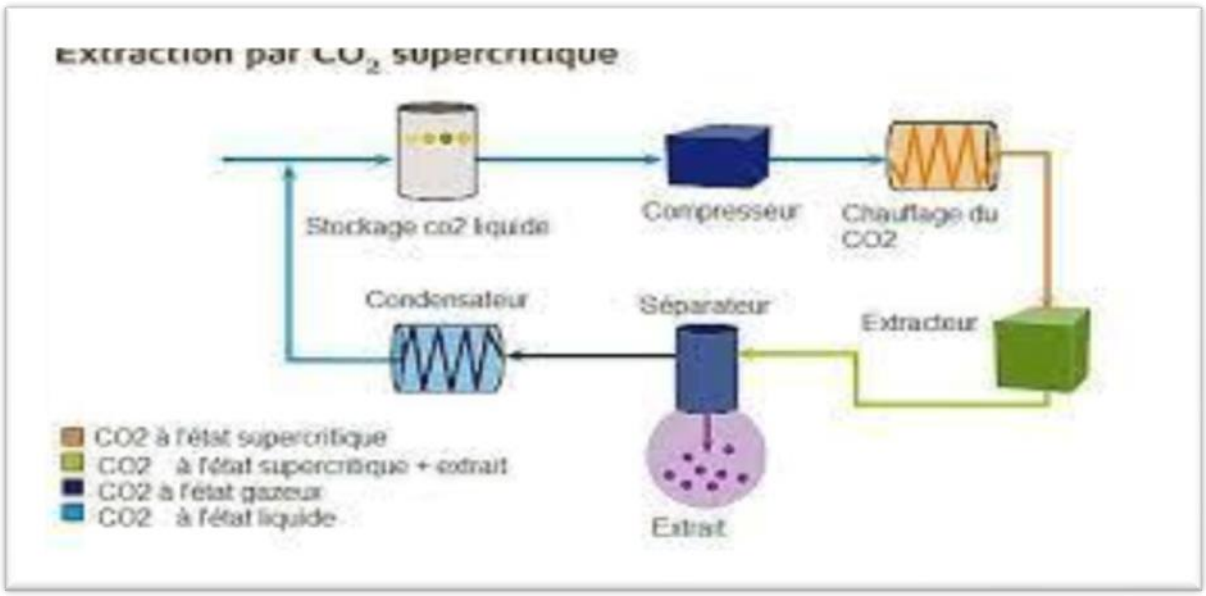


Figure (13) : Schéma du principe de la technique d'extraction par le CO_2 supercritique **(Chorfi and Sid, 2022)**

I-6- Processes for obtaining essential oils

Various processes are currently used for the extraction of products aromatics of plants. Depending on the technique used, the extraction of the products allows to obtain essential oils, ointments, concretes, absolutes, resinoids or infusions. The main physical properties implemented in operations fundamental extraction of natural aromatic materials are:

- Volatility ;
- Solubility;
- The dimensions and shapes of the particles **(Mehani, 2015)**

I-7- Distribution and location of essential oils

In a plant, essential oils can be stored in various organs **(Ghrib, 2009).** root (Vetiver), leaf (lemongrass, Eucalyptus, etc.), bark (Cinnamon), rhizomes (Ginger), flowers (Rose, lavender) and seeds (Nutmeg, Anise). The synthesis and accumulation of an essential oil in plants is generally linked to the existence of specialized histological structures located in certain points of the tissues, most often located on or near the surface of the plant **(Khebri 2011).** Essential oils exist almost only in higher plants. **(Jaubert, J. N. 2005).**

Only the most concentrated and secreted parts are harvested in the optimal production period, for example**:(Serrato-Valenti *and all .,* 1997) (Parthasarathy *and al.,* 2008).**

- Before flowering: min
- During flowering: lavender
- After flowering: seed plants
- After the dew of the morning: fragile flowers.

I-8- Physico-chemical properties of essential oils

According to **(Berramdani and Baghdadi, 2021)** and **(Bourita and Bouballi, 2017).** We can summarize the physicochemical properties of HEs as follows:

- They are generally liquid at room temperature.
- They are volatile and very rarely colored.
- They do not have the fatty and creamy touch of fixed oils.
- their density is generally lower than that of water.
- The refraction index essentially depends on the content of monoterpenes and oxygenated derivatives. A high content of monoterprènes will give a high index, however a high content of oxygen drifts will produce the opposite effect
- They are soluble in high alcohol alcohols, in most organic solvents and lipids, but not very soluble in the water.
- They are endowed with rotary power since they are mainly formed of asymmetrical compounds.
- The EO are stable at room temperature if they are adequately kept in the shelter of oxidation and polymerization caused by air, light and temperature variations.

– their boiling point varies from 160 to 240 ° C. Very alterable, sensitive to oxidation and tend to polymerize, giving rise to the formation of softwood products, it is then necessary to keep them away from light and humidity.

I-8-1- Physical properties

The physical properties of essential oils are summarized in their indices, rotational power, viscosity, density, solubility in alcohol, boiling point and freezing. Generally colorless or pale yellow, essences are liquid at room temperature. The oily nature of essential oils makes them lipid-soluble, so they are poorly soluble in water but are soluble in non-polar organic solvents, fatty oils, and in alcohols. Essential oils are extremely volatile and sensitive to oxidation. They tend to polymerize, giving rise to the formation of resinous products, which leads to the loss of its properties. Their density is generally lower than that of water (with the exception of essential oils of sassafras, clove or cinnamon are exceptions). They have a high refractive index and most deflect polarized light **(Ouibrahim, 2015).**

I-8-2- Chemical properties

Essential oils can contain around a hundred different compounds, belonging to two groups characterized by specific biogenetic origins: Terpenes and organic phenyl propane derivatives synthesized mainly from shikimic acid **(Ouibrahim, 2015).**

I-9- Clinical properties of Rosmarinus Officinalis essential oils

Rosemary essential oil is recognized for its virtues:

– Antibacterial and antifungal, it decreases the resistance of Escherichia coli to antibiotics and candida albicans to antifungals.
– Antiviral against the herpes Simplex virus.
– Antioxidants and photoprotectors against skin photos.
– Stimulant hair growth in people with localized fellowship **(Enomayry, 2022).**

I-10- Chemical composition

In plants, essential oils exist almost only in higher plants **(El Haib, 2011).** The chemical composition of an essential oil can vary within the same botanical genus, these variations can be observed within of the same species **(Mnayer, 2014).**Essential oils are mainly made up of two groups of distinct odorous compounds depending on the metabolic pathway taken or

used. These are terpenes (mono and sesquiterpenes), predominant in most essences, and aromatic compounds derived from phenylpropane (figure 14, 15 and 16) **(El Haib, 2011).**

I-10-1- Terpenes

Essential oils are made up of a certain number of terpene compounds, generally the most volatile ones whose molecular mass is not high. These constituents come from isoprene corresponding to the general formula $(C_5H_8)n$, they are also called isoprenoids or terpenoids. The term "terpenoid" defines all terpenes oxygenated, while the term "terpene" does not take into account the presence of oxygen **(Baser and Buchbauer, 2010).** Thus, we distinguish according to the carbon number: monoterpenes (C10), sesquiterpenes (C15), and less frequently diterpenes (C20), triterpenes (C30) and tetraterpenes (C40).Certain terpene compounds can be toxic, repellent or attractive toother organisms, hence their roles in interactions between plants and animals.

I-10-2- Mono terpenes

Mono terpenes contain two isoprene units (C10), an example of which is myrcene, a common mono terpene in essential oils. The myrcene molecule follows the isoprene rule which states that isoprene units are generally joined "head to tail" to make up the carbon skeletons of terpenoid molecules **(Senouci, 2020).**

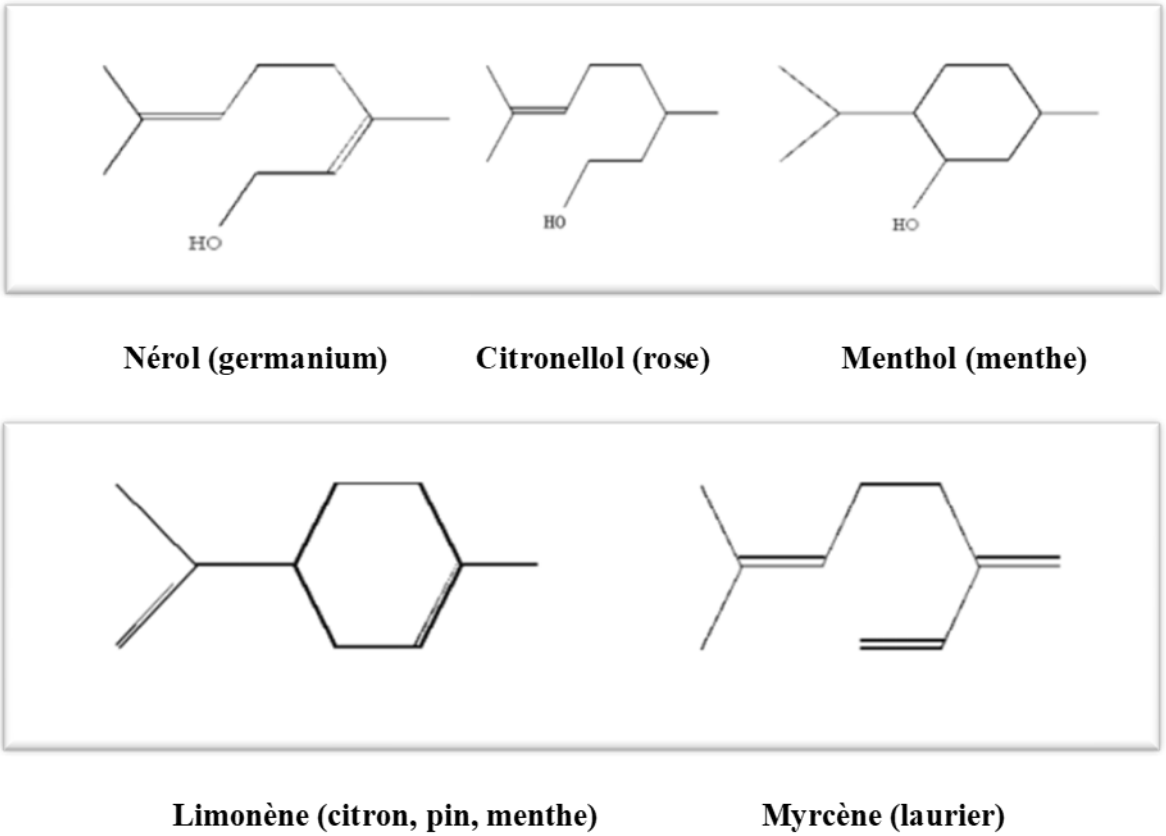


Figure (14) : Some terpenes Mono terpenes **(Andrianmontsoa, 2021).**

I-10-3- Sesquiterpenes

Sesquiterpenes contain three isoprene units (C15), shows sesquiterpene (E)-beta farnesene, an open-chain sesquiterpene. One of the characteristics of sesquiterpenes is that they easily undergo reactions creating molecular structures with closed rings, the molecular shapes formed by the closed rings can be classified into subgroups of sesquiterpenes **(Senouci, 2020).**

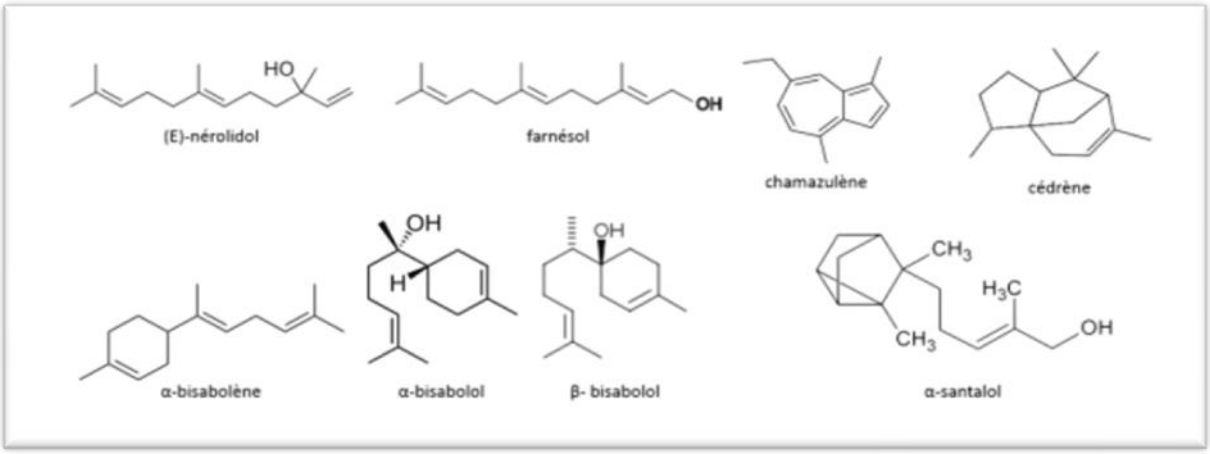


Figure (15) : Some terpenes and sesquiterpenes **(Deschapper, 2017).**

I-10-4- Aromatic compounds

The aromatic compounds of essential oils are mainly C6-C3 phenylpropane derivatives. They are much less common than terpenes. They may include phenols (chavicol, eugenol), aldehydes (cinnamaldehyde), alcohols (cinnamic alcohol), methoxy derivatives (anethol, estragol) or methylene dioxy (myristicin, safrole) **(Mnayer, 2014).**

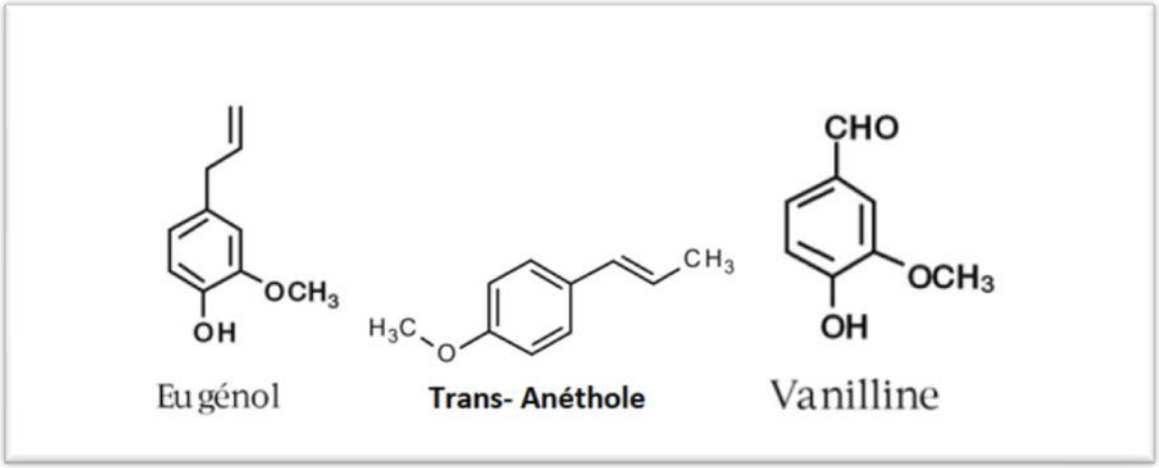


Figure (16) : Examples of aromatic compounds **(Kaoune and Chabane, 2017).**

I-11- Essential oils biochemistry

Essential oils contain a considerable number of biochemical families (chemotypes). We see that they are not made up of fatty acids, nor any other fatty substances. They consist of:

- Mono Terpenes.
- Sesquiterpenes.
- Aromatic compounds.
- Composed of various origins **(Boubrit Boussad, 2007)**.

I-11-1- Antibacterial activity of essential oils

The first highlighting of the antibacterial action of the HES was carried out by Delacroix in 1881. Since then, many oils have been determined as antibacterial. With a very extensive action spectrum, because they act against a large number of bacteria. This variable activity from one bacterial strain to another and from one essential oil to the other, it can be bactericide or bacteriostatic (L 'Bacteriostatic activity is often more assimilated to essential oils than bactericidal activity). EO act both on positive gram bacteria and gram negative bacteria which recognized as the least sensitive thanks to the nature of the cell wall. This wall contains an additional external membrane which givesprotection, on the contrary, the positive Gram bacteria have that the peptidoglycan despite the fact that the latter is thicker **(Djebbariand Barki, 2021).**

The antibacterial action of EO takes place in three phases the loss of cellular constituents.

- Attack of the bacterial wall by the H.E, causing an increase in permeability
- Acidification of the interior of the cell, blocking the production of cellular energy and the synthesis of structural components.
- Destruction of genetic material, leading to the death of the bacteria **(Tayeb-Cherif andMenacer, 2016).**

I-11-2- Anti-biofilm activity

Essential oils have been shown to be very effective against microbial biofilms, where they can act in several ways. Essential oils at low concentrations inhibit the formation of bacterial biofilms by several mechanisms. In particular, the activation of counter-stress

response genes which in turn reduce the production of extracellular polysaccharides **(Benbelaid, 2015).**

I-11-3- Mode of action

Due to the variability in the quantities and profiles of essential oil components, it is likely that their antimicrobial activity is not attributable to a single mechanism, but to several sites of action at the cellular level. The mode of action of essential oils depends primarily on the type and characteristics of the active components, in particular their hydrophobic property which allows them to penetrate the phospholipid double layer of the bacterial cell membrane.

Certain phenolic compounds in essential oils interfere with the membrane proteins of microorganisms such as the ATPase enzyme, either by direct action on the hydrophobic part of the protein, or by interfering in the translocation of protons in the membrane preventing the phosphorylation of the ADP. Essential oils can also inhibit the synthesis of DNA, RNA, proteins and polysaccharides **(El Amri *and al*., 2014).**

I-12-Types of *Rosmarinus officinalis* essential oils

There are 3 types of Rosmarinus officinalis essential oil which vary according to geographical origin and chemical composition. They are named according to the active principle which predominates **(Boudjebir, 2017).**

Table(04): Different chemotypes of Rosmarinus officinalis **(Boudjebir, 2017).**

	Rosmarinus officinalis at cineol	Rosmarinus officinalis with verbenone	Rosmarinus officinalis with camphor
origin	Morocco, distilled organ: branches.	France, distilled organ: branches.	France (Midi) distilled organ: branches.
Active subtances	Oxides: 1.8cineole (60%) ketones: Camphor (10%).	Ketones: Verbenone (30%) Camphor (7%) Oxides: 1.8 cineole (20%)/bronyl acetate esters.	Ketones: Camphor (30%) Oxides: 1.8 cineole (30%) Monoterpene (40%): α and β-pinene. owner
properties	Mucolytic, expectorant, anticatarrhal Respiratory anti-	Hepatic regulator, choleretic, cholagogue Mucolytic, expectorant General tonic	Cardiotonic muscle relaxant (low dose) Choleretic emmenagogue and

infectious and fungicide	Mucolytic cholagogue

I-13- Facteurs affectant la variabilité de la composition des huiles essentielles

Les activités biologiques à large spectre des huiles essentielles pourraient être attribuées à la complexité et à la variabilité de leur composition chimique qui sont influencées par de nombreux facteurs **(Mahendra *and al*., 2017).** Divers travaux ont démontré que le contenu de l'huile essentielle peut changer en fonction des différences de culture, d'origine, de stade végétatif mais également de facteurs environnementaux comme la température, la pression atmosphérique, la vitesse du vent, l'augmentation des précipitations et l'altitude **(Djerrad *and al*., 2015).**Ces facteurs influent sur la croissance de la plante **(Korner, 2007)**,la physiologie et la morphologie des plantes, l'écologie des gènes et les tendances des organes qui dans le sens chimique, conduisent à la différenciation entre les espèces **(Reisch *and al*., 2005).** En outre, d'autres études ont révélé une grande variabilité dans la composition chimique des huiles essentielles, qui était principalement corrélée à la variation géographique, conditions environnementales et agronomiques **(Moghtader *and al*., 2009),** temps de récolte et méthodes d'extractions **(Djouahri *and al*., 2013).**

I-14-Toxicity of essential oils

The use of essential oils should not be taken lightly. Toxic effects vary greatly from one essential oil to another and depend greatly on the sensitivity of the consumers. Essential oils are complex mixtures of molecules, which are can distinguish two groups: terpenes and aromatics. Terpenes and their derivatives are formed of isoprene units (branched pentacarbon units). For this range of compounds, only molecules of low weight, between 10 and 20 carbon atoms, are present in essential oils. Therefore, they can more easily penetrate our skin and thus cause allergies and inflammation. However, these effects are caused mainly by other compounds such as sesquiterpene lactones, cinnamic aldehyde and phenylpropanoids. Essential oils containing certain aromatic compounds, including phenols and derivatives, such as eugenol, thymol and carvacrol, should be used with caution. These molecules can cause severe irritations on sensitive skin or mucous membranes. In addition, liver cells can be damaged when the doses taken are high and the duration of the treatment is long. Other families of compounds also turn out to be toxic. These are ketones, aldehydes and some

esters. The consequences on our health range from photosensitization and the risks of abortion, in the most serious cases **(Cazzola and Doublet, 2015).**

Chapiter III Effect of rosmarinus officianalis for hair

1-Hair structure

Hair provides protection to the scalp against external shocks and attacks such as heat, cold, UV radiation... The hair is implanted obliquely in the skin. It is composed of two very distinct parts: a hidden part, the root and avisible part, the stem. Thus, we distinguish

- The isthmus of the hair follicle: this is the area where the sebaceous gland(s) meet;
- The bulge: is formed by a cellular subpopulation of the external epithelial sheath, located at the level of the middle portion of the hair follicle, and more precisely at level of the insertion zone of the arrector pili muscle.
- The supra-isthmic region: includes the hair shaft and the infundibulum, cavity incommunication with the surface of the skin, bordered by an epithelium in continuity withthe surface epidermis;
- The subisthmic region: formed by the root of the hair and its sheaths: the sheathouter epithelial sheath (GEE) and the inner epithelial sheath (GEI). (histology of skin and hair follicles)

1-1- The root

The root ends in its depth with a swollen part called the bulb. She is housed in an epidermal invagination: the follicle, surrounded by a connective layer called the fibrous sac. Around the follicle there is the arrector pili muscle and several sebaceous glands hence the name pilosebaceous follicle.

1-1-1- The pilosebaceous follicle

It is a thin envelope of epidermis hollowed out in the dermis which shelters the hair root at4 mm below the scalp (Figure17). The hair follicle is formed by several compartments, some of dermal origin (sheath conjunctiva and dermal papilla), the others are epithelial in nature (external epithelial sheaths and internal, hair shaft and sebaceous gland). These different parts are all essential to the keratin manufacturing **(Auteur anonyme. 2005). (Bernard Bruno, 2006). (Centre clauderer web site ,Octobre 2012).**

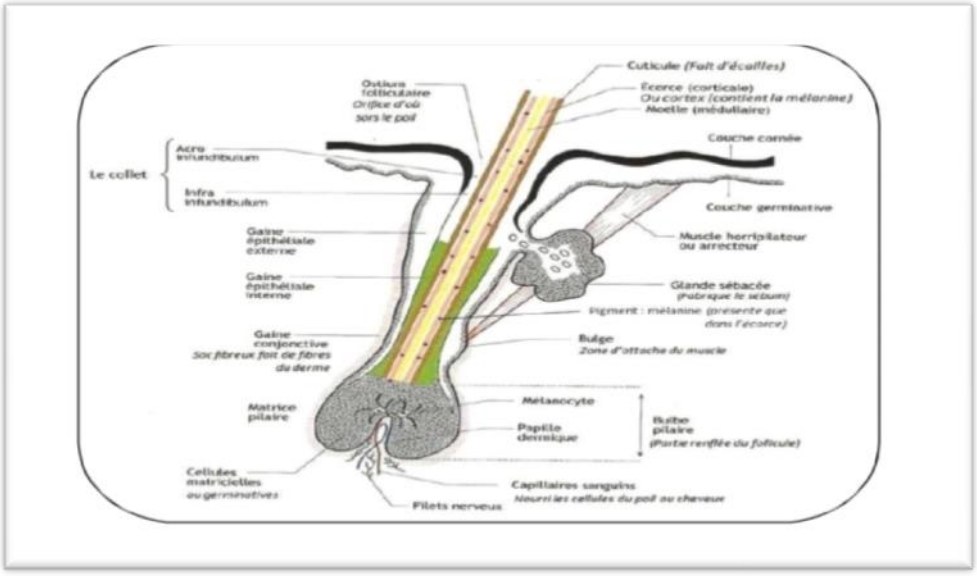


Figure (17) : Detailed diagram of the pilosebaceous follicle **(Poils and hair_Canalblog)**

a) The dermal papilla

Invagination of the epidermis into the dermis, the dermal papilla is an essential arearichly vascularized which participates in the nutrition and regulation of hair growthby its reserve of growth factors and extracellular matrix proteins (collagen I and III, laminin 1 and 5…). Composed of dermal collagen and keratinocytes, it connects the bottom of the follicle to the rest of the body. The vascularization of this papilla is essential in the life of the pilosebaceous follicle and hair growth **(Centre clauderer web site, Octobre 2012).**

b) The hair matrix

Area covering the dermal papilla, it generates a cluster of little matrix cells differentiated cells called keratinocytes and transform them into hair: this is the phenomenon of keratinization. Keratinocytes in the germ layer divide every 39 hours to produce birth of daughter cells which will be pushed upwards when other cells will be born. A little higher, cellular differentiation will allow the formation of four cell types as they progress towards the surface:

the central cells will form the 3 parts of the hair (cuticle, cortex, medulla);

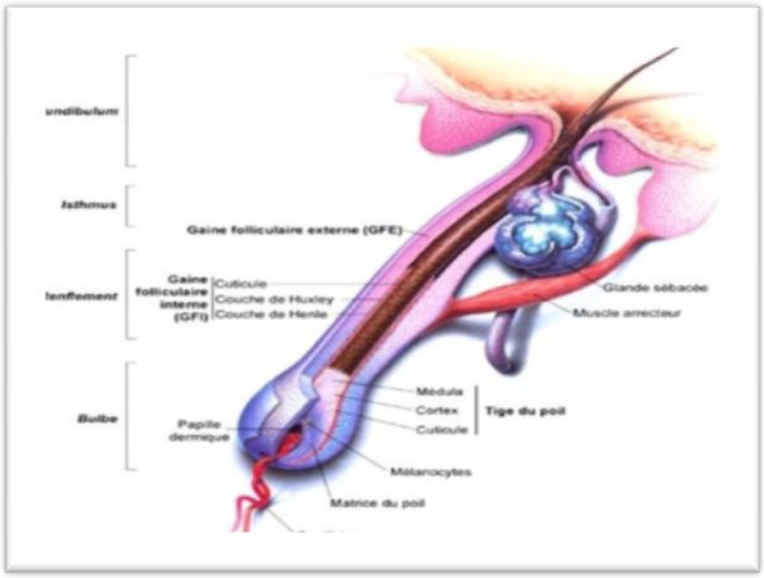
 the peripheral cells will form the epithelial sheath **(3D journey to the heart of the hair ,2012). (Jean Laudereau, 1995.).** It is also this matrix which conditions the shape of the hair. It is distributed in a way homogeneous around an axis of symmetry for straight hair whereas it will be more important on one side for curly hair. **(Centre clauderer web site, Octobre 2012). (Melissopoulos *and al*., 1998).**

c) The epithelial sheaths

The outer epithelial sheath (EGE) forms a tube through which the hair passes to emerge and reach the surface of the skin. As for the internal epithelial sheath (GEI), it is attached to the hair shaft and forms a keratinized envelope which surrounds the hair in the process of formation. It contains many eosinophilic trichohyalin granules. The main role of this protein is to aggregate keratin filaments. This sheath has three layers (see Figure 2):

- an internal layer: the sheath cuticle; it acts as a barrier to diffusion and it thus maintains a concentration gradient of morphogenic factors inside the follicle bulb;
- an intermediate layer: the Huxley layer made of one or two layers of cells containing large trichohyalin granules;
- an outer layer: the Henle layer made of a layer of cuboidal cells rich in trichohyaline granules and keratinizing very early in the part lower part of the isthmus.

(http://tpecheveuxraidesoufrises.e-monsite.com/).



Figure(18) : Detailed diagram of a pilosebaceous follicle showing the different layers of the (GEI.**Image : Schéma détaillé d'un follicule pilo-sébacé.URL)**

1-1-2- The sebaceous gland

These are exocrine glands attached to hair. The serving cells secretion of the gland are called sebocytes and their function is to produce sebum: made up of waxes, triglycerides and squalenes. For this, they will undergo a differentiation from the periphery to the center of the gland.Of oily consistency, sebum lubricates the hair and protects it with its properties. antifungal and antibacterial. Like all glands, the sebaceous gland is under hormonal

dependence and certain hormonal imbalances can lead to disorders capillaries. **(Molinari E, and al ,2010.). (Pierard-Franchimont C).**

II-2- The hair shaft

is the visible part of the hair located above the skin surface. It is made up of three very distinct consecutive layers:

- **the outer layer :** the cuticle;
- **the middle layer :** the cortex;
- **the inner layer :** the marrowhair shaft

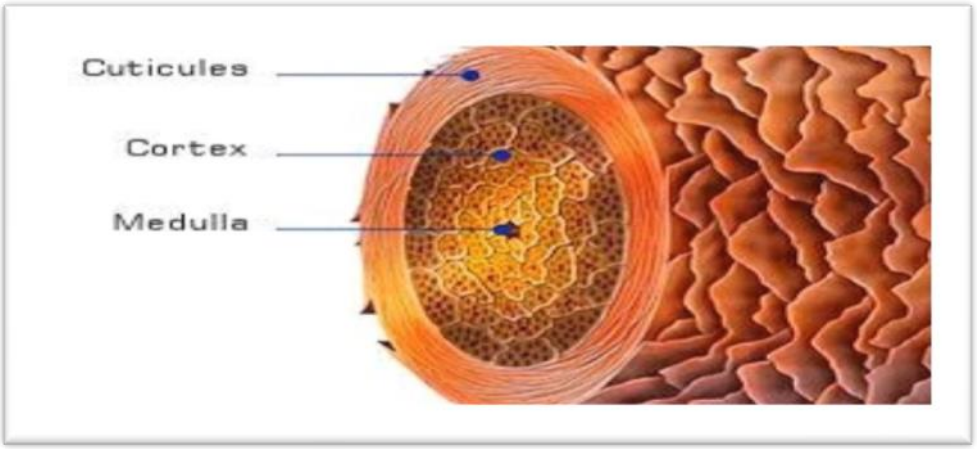
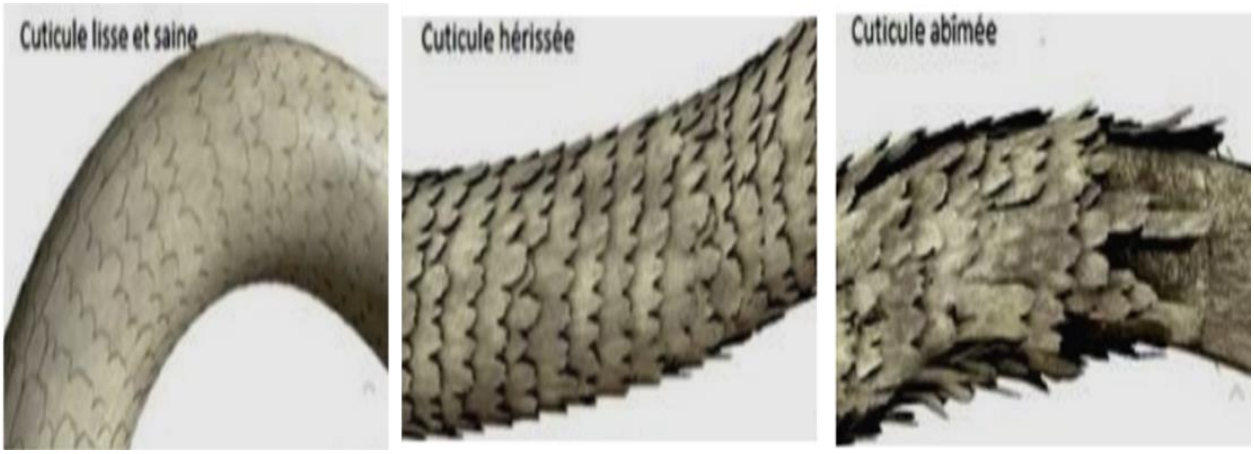


Figure (19): Cross section of a hair. **(Image: Cross section of a hair).**

II-2-1-The outer layer

Also called cuticle, the outer layer is the most superficial layer of the stem pilar. **(Franbourg *and al.*, 2003).** It is made up of several layers of keratinocytes (6 to 10), flattened and stacked on top of each other, in the shape of scales. These are degenerated cells which have no apparent nucleus and no longer contain nucleic acid. They are strongly adherent to each other and to the stem. These layers are themselves composed of three parts:

- the endocuticle inside, very resistant;
- the exocuticle, fragile;
- the epicuticle, a thin membrane that surrounds the scales. It is semi-permeable and therefore allows low molecular weight molecules to pass. The cuticle is, however, very thin and transparent so that it reveals the cortical tint pigment. It protects the hair and gives it shine and candy. The keratin in this layer is hard and rich in sulfur.**(Bouhanna, 1995).**



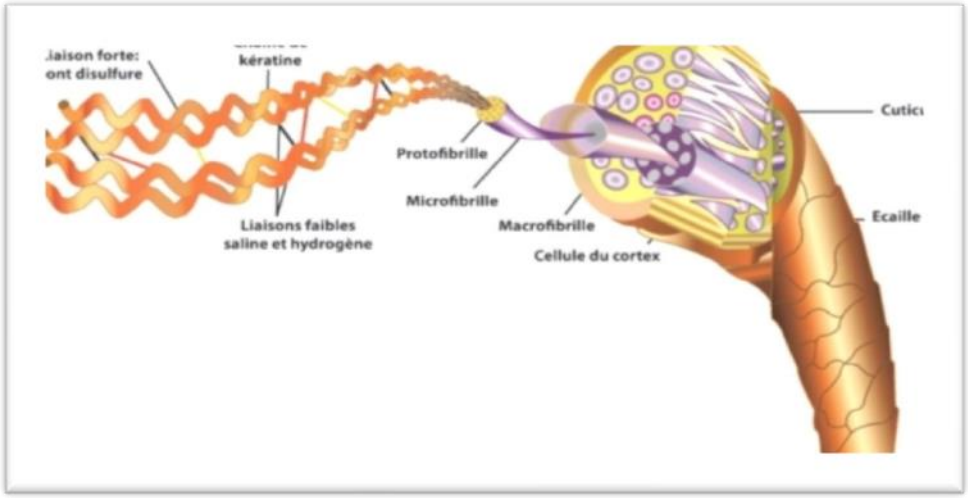
Figure(20) : Comparison of the scales of the hair cuticle. Three stages of progression: healthy, sensitized and damaged**. (Image: comparison of the scales of the cuticle of a hair)**

2-2-The middle layer

The middle layer, also called the cortex, represents the most significant amount of hair (around 90%). It fills with keratin filaments after total differentiation of keratinocytes. As opposed to the flexible keratin of the skin, the Hair keratin is a tough fiber. Its structure is that of a heterodimer composed of type 2, basophilic, and type 1, acidophilic protein fibers, particularly rich in cystine dimers. **(Langbein L, and al ,2001). (Wolfram LJ. 2003).** The breakdown and reconstitution of keratin disulfide bridges form the very basis of hair permanence. The cortex determines the firmness and elasticity of the hair and contains melanosomes responsible for hair color. Oval grains of eumelanin and lamellar grains of pheomelanin constitute the broad spectrum of hair color ranging from brown dark to blond **(Bouhanna, 2004).**

2-3- The inner layer

The inner layer, also called the medulla, forms the heart of the hair shaft. Its cellsundergo moderate keratinization containing much fewer sulfur bridges, this iswhy we speak of “soft” keratin as opposed to that of the cortex and cuticle.It contains vacuoles which are gradually replaced by spaces filled with air.The presence of melanosomes is also observed (Image: The three types of hair in the world) (The study of hair. Walsh William J).



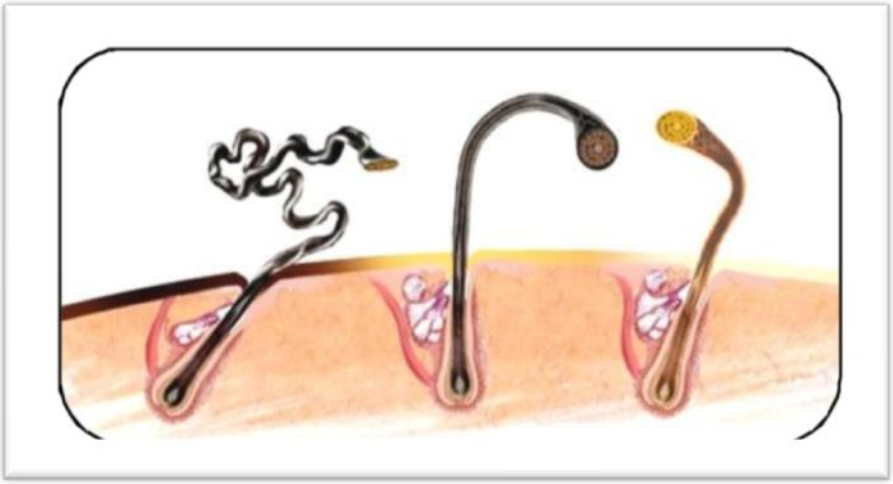
Figure(21): Cross section of a hair to a keratin molecule. **(Image: from a hair to a keratin molecule).**

3- Histological Variability According To Populations

We do not find differences in the biochemical composition of the hair of one population to another, but the hair and scalp have particularities structural, anatomical and physiological. We thus distinguish (see Figure x):

- Caucasian type hair (European and Indian) which often has a hair shaft oval and great variability in the shape and color of their hair;
- Asian hair types which have a round section, a black color and a very stiff shape;
- African hair which is frizzy, thick, dense and twisted. This structure of hair is necessary to protect the scalp against UV ray damage. Why do some people have curly hair and others have straight hair? The curvature is probably an internal stress in the fiber, resulting from an asymmetry affecting the differentiation programs of all the different compartments of the follicle at the level of the bulb. The follicle associated with curly hair is curved and characterized by a retro curvature at the bulb.

In addition, matrix cells proliferate more actively on the convex side than on the concave side of this retro-curvature. The molecular origin of this bulbar asymmetry is not known to date, but the researchers believe that it is intrinsic to the follicle since when follicles are dissected are cultivated, they continue to produce fiber with a molecular structure and organization maintained. For example, a follicle associated with a curved hair will produce in vitro a curved stem, thus demonstrating the intrinsic character of the form. **(Bouhanna P.2006.). (Bernard BA.2006). (Voyage 3D on the website ,2012).**



Figure(22): The three types of hair in the world. From left to right: African hair, Asian hair and Caucasian hair**. (Image: The three types of hair in the world).**

4- CAUSE OF HAIR LOSS

- Heredity
- Physical and Emotional Stress
- Alopecia
- Anemia
- Fungal or bacterial infections of the scalp
- Hormonal changes **(Hargaran and Sood, 2022).**

5- BENEFITS OF ROSMARINUS OFFICINALIS L. LEAF EXTRACT TO TREAT HAIR LOSS

There is ample evidence that serums, conditioners and shampoos containing rosemary oil or rosemary leaf extract can stimulate hair growth in people with relatively healthy scalps.A growing body of research also shows that rosemary can treat hair loss and promote new hair

growth in people with androgenetic alopecia. Let's look at some of the more common causes of hair loss and how rosemary can help with regrowth in each case.**(Rutuja *and al.*, 2023).**

6- SOME SEVEARE PROBLEM ASSOCIATE WITH HAIR

- Alopecia Areata
- Telogen Effluvium
- Scalp Folliculitis
- Scalp Psoriasis

- Seborrheic Dermatiti **(Hargaran and Sood, 2022).**

7- MECHANISM ACTION OF ROSMARINUS OFFICINALIS L

Due to its anti-microbial and anti-inflammatory properties, as well as its blood circulation and fatty acid content, rosemary oil has proven to be a natural remedy worth exploring for those looking to improve their hair growth. Whether you have coarse or fine hair, you can incorporate this essential oil into your hair care routine with a few simple tips and tricks.

- **Antimicrobial:** Rosemary oil has antimicrobial properties that can help eliminate dandruff and promote a healthy scalp.
- **Anti-inflammatory:** The oil has antiinflammatory properties that soothe the scalp and reduce irritation.
- **Increased circulation:** Rosemary oil can stimulate blood circulation when applied to the scalp, which helps promote hair growth.
- **Contains fatty acids:** The oil contains fatty acids that nourish hair follicles and provide essential nutrients for healthy hair growth.

Rosemary (*Rosmarinus officinalis*) exhibits antimicrobial properties primarily due to its essential oils, such as cineole, camphor, and borneol. These compounds have been found to have antimicrobial effects against various bacteria, fungi, and viruses.

7-1- Cineole (Eucalyptol)

It has been shown to have antibacterial and antifungal properties. Cineole can disrupt the cell membranes of bacteria, leading to cell death.

7-2- Camphor

This component possesses antimicrobial and antifungal activities. It can interfere with the growth and survival of microorganisms.

7-3- Borneol

Borneol has been reported to have antimicrobial effects against various bacteria. It may disrupt microbial membranes and interfere with essential cellular processes.

7-4- Phenolic Compounds

Rosemary contains phenolic compounds like rosmarinic acid, which contribute to its antimicrobial activity. These compounds can disrupt microbial cell walls and inhibit enzymes essential for microbial growth.

7 -5- Antioxidant Activity

Rosemary's antioxidant properties also play a role in its antimicrobial effects. By reducing oxidative stress, it canindirectly inhibit the growth of certain microorganisms.

In summary, the antimicrobial mechanism of action of Rosemary involves disrupting cell membranes, interfering with cellular processes, and exerting antioxidant effects. It's important to note that while these properties have been observed in laboratory studies, the application in real-world scenarios may vary, and further research is ongoing **(Hillmann *and al.*, 2011).**

8- Research on Rosemary Oil for Hair Growth

Scientific studies have investigated the effectiveness of rosemary extract for hair growth,although more research is needed to understand its effectiveness. One study compared rosemary oil to minoxidil, a popular hair growth agent. The results showed that hair growth increased significantly in both groups after six months of treatment.Another study found that rosemary extract can affect blood circulation and skin health, possibly promoting hair growth.

In addition, rosemary extract has been shown to have antibacterial and antifungal properties, suggesting that it may be beneficial in promoting a healthy scalp environment. However, it is important to note that current research on rosemary oil for hair growth is limited and more research is needed to confirm its effectiveness and safety. People should consult a doctor before adding rosemary oil to their hair care routine **(Hillmann *and al.*, 2011).**

Chapte IV: Materials and méthods

III- Materials and méthods

III-1- Study materials

This work was carried out in the teaching laboratory of the Faculty of Natural and Life Sciences at the ***Echahid Hamma Lakhdar*** University, El Oued. The antibacterial activity was carried out at the EL-MEDJED medical laboratory, El Oued. High-performance liquid chromatography (HPLC) and Gas chromatography/mass spectrometry analysis (GC/MS) in CRAPC of Ouargla.

III-1-1- Matériel biologique

III-1-1-1- Plant matériel

The plant material is Rosmarinus officinalis. Samples were collected by hand from the mountain in Douar El-Gharanta, Municipality of Zebrabar, Lakhdaria District, Bouira wilaya in February 2024. The harvesting was done in the early morning and at the time of bud blooming, and the harvesting was only related to the aerial part of the adult tree and was randomly selected.

III-1-1-2- Microorganisms used (Microbial strains)

We used a reference strain of *Candida albicans* ATCC 10231 and four bacterial strains, including two Gram-negative strains, *Pseudomonas aeruginosa* ATCC 27853 and *Escherichia coli* ATCC 25922, and two Gram-positive strains, *Staphylococcus aureus* ATCC 25923 and *Bacillus subtilis* ATCC 25973.

❖ **Laboratory Equipment**

- Mueller-Hinton culture media
- Petri dishes
- Incubator set at 37°C
- Refrigerator
- Autoclave
- Bunsen burner
- Precision balance
- Water bath
- Sterile loop
- Sterile swab
- Micropipette

- Cones
- Sterile Pasteur pipettes
- McFarland Standard No. 0.5 (1.5 x 10^8 CFU/ml)
- VITEK® DENSICHEK® McFarland
- Sterile physiological saline solution (0.9% NaCl)
- Sterile distilled water
- 5% DMSO

III-2- Methods

III-2-1- Drying the Rosmarinus officinalis plant

The harvested plant material was thoroughly dried at room temperature, protected from light and humidity for a period of 10 days, and then transported to the microbiology laboratory of the living beings department to begin the extraction process.

Figure(23) *Rosmarinus officinalis* during drying **(Photo personnelle, 2024).**

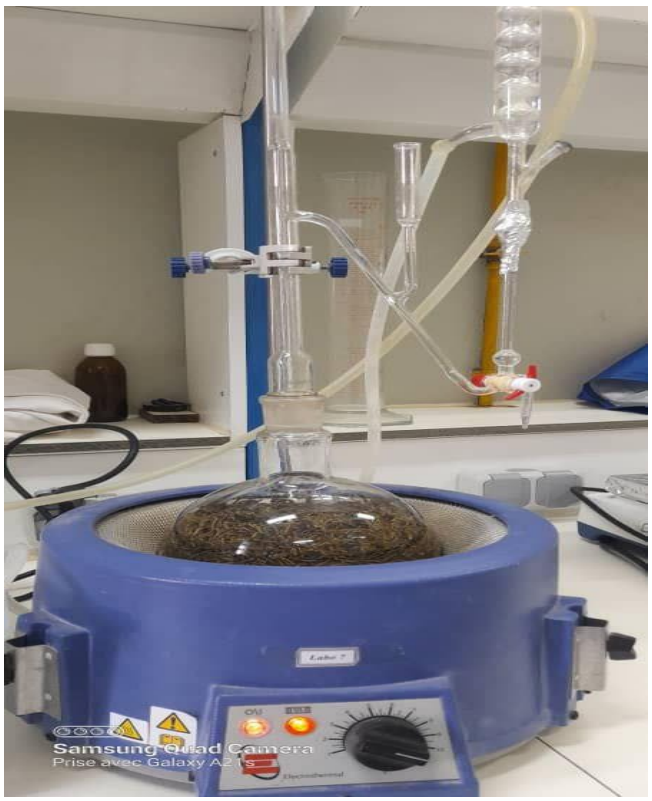
III-2-1-1- *Rosmarinus officinalis* plant grinding

Dried Rosmarinus officinalis leaves were ground into very small pieces using a mortar and pestle, then sieved to remove dust and impurities. These were then sent directly for extraction.

III-2-2- Preparation of extracts

III-2-2-1- Extraction of *Rosmarinus officinalis* essential oil

To extract essential oils, a commonly used method ishydrodistillation. This technique involves boiling water and plants in a flask to releaseto release the fragrant molecules, which are then carried away by the steam created. The vapors pass through a condenser where they are cooled and condensed, then collected in a container.To ensure the purity of the extract obtained, it is important tothoroughly clean the distillation unit before use, removing any dust or grease that mightdust or grease that could contaminate the oil (Toure, 2015). Extraction is generally carried out at atmospheric pressure **(Boukhatem *and al*., 2019).**



Figure(24) Clevenger hydrodistillation apparatus **(original)**

❖ **Determination of extract yield**

Essential oil yield is defined as the ratio of the mass of essential oil to the mass of plant material used during extraction, and is calculated according to the following formula **(Bertella, 2019 ; Mouchem Metahri, 2015).**

$$RHE = MHE/MPS \times 100$$

- **RHE:** Essential oil yield (%).
- **MHE:** Mass of essential oil obtained (g).
- **MPS:** Mass of treated dry plant (g).

III-2-2-2- Preparation of the aqueous extract

The powder of the aerial parts of aerial rosemary was soaked in about 10 g in 100 ml of distilled water and left atroom temperature for 24 hours in the dark. After that, it was filtered with filter paper. After extraction, the sample was extensively dried at 40°C. The extract was weighed and cooled at 4°C for further analysis in the future **(Murugan and Parimelazhagan, 2014).**

III-2-2-3- Methanolic extract

10 g of the dried plant were macerated in 100 mL of MeOH at room temperature in dark for 24 h. The solvent was evaporated under reduced pressure at 60 °C by rotary evaporator type Buchi R-200 **(Chouikh , 2015).**

III-2-2-4- Extraction of flavonoids

30 g of the plant were macerated in 300 mL of MeOH for 24 h. After filtration and evaporation of the solvent, the first extraction was obtained with 150 mL of hot water and 150 mL of ethyl acetate (2 times). In the second extraction were added 150 mL of 1-butanol (2 times) in the aqueous phase. The two organic phases (ethyl acetate and 1-butanol) were evaporated in a rotary evaporator device to obtain two phases of flavonoids, *i.e.* ethyl acetate and 1-butanol. **(Chouikh , 2015).**

III-2-3- Determination of phenolic compounds

III-2-3-1- Determination of Total Phenolic content (TPC)

The polyphenols were identified using the Folin- Ciocalteu method. Per gram of extract, to 1mL of 10% Folin-Ciocalteu reagent with 0.2mL of the aqueous extract of *Rosmarinus officinalis* was added. The addition of 800µL of saturated sodium carbonate (75 g/L) was made after 4 minutes. After 2 hours of incubation at room temperature, the absorbance was measured at 765 nm. To ensure that the results could be replicated, the tests were run three timesthe total phenolic content was reported as mg equivalent of gallic acid,the total phenolic content was expressed in mg equivalent of gallic acid per gram of extract **(LAIB, 2023)** .

III-2-3-2- Determination of Total Flavonoids content (TFC)

We employed a colorimetric technique with aluminum chloride ($AlCl_3$) to determine the total flavonoids concentration of the *Rosmarinus* extract. Added 1mL of the sample with 1mL of $AlCl_3$, and on the other hand with 1mL of the standard. At 430 nm, the absorbance was measured, after 30 minutes against the prepared reagent blank. In order to determine the results, a linear calibration equation using quercetin as the standard was utilized. The results were represented as milligrams of quercetin per gram of extract **(Laib, 2023).**

III-2-4- Assessment of biological activities

III-2-4-1- Study of total anti-oxidant activity

A- DPPH free radical scavenging testof essential oilof *Rosmarinus officinalis*

The anti-oxidant activity of essential oils can be measured byusing a simple, rapid and easy-to-implement method: the DPPH method.

DPPH method, in which DPPH is a stable free radical with an absorbance band at 517nm,used to assess the antioxidant activity of pure compounds or complex mixtures. The methodology is based on the decrease in absorbance of a methanolic solution of methanolic solution of DPPH following addition of the anti-oxidant (Bernardi et al., 2007).Onuses three essential rosemary oils as active ingredients. The anti-free radical activity of these extracts is measured using the method described by **(ESSafi and al, 2007).**

- 20 µl of the extract to be tested.
- 1 ml of a methanolic solution of DPPH.
- The optical density (OD) is measured by spectrophotometer at 517 nm, after 30 minutes incubation at room temperature in the dark, the decrease in absorbance is absorbance is converted to percent Scavenger activity using the following equation as follows:

  Scavenger activity (%)= (A control - A sample/ A control) × 100

❖ **A control:** absorbance of the control

❖ **A sample:** absorbance of oils tested.

B- DPPH free radical scavenging test of essential oilof *Rosmarinus officinal* extract

2.4 mg of DPPH is dissolved in 100 mL of methanol to make the 1,1-diphenyl-2-picrylhydrazyl solution. 1mL of each phenolic extract (or ascorbic acid as a control) is added to 1 mL of the DPPH solution previously produced. The reaction mixture is quickly agitated

and then maintained at room temperature for 30 minutes in the dark to complete the reaction. The reaction medium's absorbance is measured at 517 nm **(Mansouri *and al*., 2005).**

III-2-4-2- Ferric Reducing Antioxidant Power (FRAP) test

A- (FRAP) test of essential oilof *Rosmarinus officinal*

The FRAP method is based on the reduction of ferric ion (Fe^{3+}) to ferrous ion (Fe^{2+}). This method assesses the reducing power of compounds. The presence of reducing agents (HA) in plant extracts causes the reduction of Fe3+ / ferricyanide complex to the ferrous form. Consequently, Fe^{2+} can be assessed by measuring and monitoring the increase in density of the cyan blue colour in the reaction medium at 470 nm. In fact, the FeCl3/K3Fe (CN)6 system gives the method sensitivity for the "semi-quantitative" determination of antioxidant concentrations, which participate in the redox reaction **(L'arabe and al.,2016).**

- **How It Works**

625µl of phosphate buffer (0.1M; pH = 6.6) and 625µl of a 1% potassium ferricyanide solution were added to 1ml of extract or ascorbic acid as a positive control at various concentrations (5 to 30µg/ml). The mixture was stirred and incubated at 50°C for 20 min. After incubation, 625µl of 10% TCA (trichloroacetic acid) was added, followed by centrifugation at 3000xg for 10 minutes. 625µl of supernatant was removed, diluted with 625µl of distilled water and then 0.5ml of 0.1% Fe Cl3 was added, after which the sample was left to stand in the dark for 15 minutes before measuring absorbance at 470 nm. The antioxidant activity linked to the reducing power of the extracts is expressed as Reducing Power (RP) using the following formula: **(Serigne and al., 2017).**

$$RP = (Aa- Ab)/ Aa*100$$

- **Aa:** absorbance of the extract
- **Ab:** absorbance of the blank

B- (FRAP) testof aqueous, alcoholic extract

The reducing power of the extract was determined using Oyaizu's methods (Oraiza, 1986). In distilled water, the extract was mixed with phosphate buffer (2.5 mL, 0.2 M, pH 6.6) and 1% potassium ferricyanide water solution (2.5 mL, K3 [Fe (CN) 6]) at differentconcentrations (mg/mL). The mixture was incubated at 50°C for 20 minutes; the mixture was centrifuged for 10 minutes at 3000 rpm after Aliquots of trichloroacetic acid (2.5mL, 10% aqueous solution) were added. A freshly produced FeCl3 (0.5mL, 0.1%)

solution was combined with the supernatant (2.5mL) and purified water (2.5mL) At 700 nm, the absorbance wasmeasured. A positive control was employed, which was ascorbic acid

III-2-4-3- Agar Diffusion Method (Well Method)

This is the basic technique used to study the antimicrobial effect of a substance. Petri dishes containing Sabouraud dextrose agar supplemented with 2% glucose (for yeasts) and Mueller-Hinton agar (for bacteria) are aseptically inoculated with a suspension of 10^6 cells/mL obtained from a young culture of yeasts or bacteria, respectively. Inoculation is done by swabbing. After the dishes have dried, the agar is perforated at the center using the upper part of a Pasteur pipette. The resulting cavities are filled with the aqueous solution of the extract at concentrations of (120, 60, 30, and 15 mg/mL) (approximately 50 µL per well).

The volatile essential oil solution is then prepared for antibacterial effectiveness testing by dissolving the oil in dimethyl sulfoxide (DMSO) to achieve a final concentration of (50, 25, 10 % V/V). **(Kiehlbauch 2000) .**

The dishes are incubated in an incubator at 37°C for 48 hours for yeasts and 24 hours for bacteria. Inhibitory action is indicated by the formation of a zone of inhibition around the wells. The results are read by measuring the diameters of the inhibition zones. A product is considered active if the diameter of the inhibition zone is greater than 6mm. **(Bonev 2008)**

III-2-5- High-performance liquid chromatography (HPLC)

HPLC (High Performance Liquid Chromatography) is a technique for separating of the components of a mixture through a chromatography columnchromatography column filled with stationary particles, where the components are separated according to their affinities with the stationary and mobile phase **(Žuvela and al. 2019).**

❖ **Apparatus:**

The Shimadzu Prominence liquid chromatography model was used to perform the characterization of naringin. The experiment was conducted using a thermostable column compartment, an in-line degasser and an SPD-20A UV detector. An analytical column Shim-pack VP-ODS C18 (4.6 mm x 250 mm, 5 µm, supplied by Shimadzu Co., Japan).

❖ **Procedure:**

The procedure for characterizing Rosmarinus extracrt by HPLC begins with the preparation of a sample in acetonitrile/methanol solution at a known concentration. This solution is then injected into the chromatography column using a high-pressure pump, which pushes the solution through the column.

which pushes the solution through the column. The components of the mixture then separate according to affinity with the stationary and mobile phases. The spectrophotometer detector measures the absorption of individual components as they pass through the column. The data are recorded by the computer system for subsequent analysis.

Table 05 :The analyzes were carried out using an HPLC-RP-C18 chromatograph, equipped with the following elements:

Pomp	LC 20AL ,LC20AL
Characteristics of the column	length × diameter =125 mm × 4.6 mm Pore diameter = 5µm
Oven	CTO 20A
Detector	UV SPD-20A
Temperature	Oven :30°C Maximum :90°C
Eluent B	acéto-nitrile
Eluent D	1% Acetic acid/ ultra-pure water
Volume injected	10µl

III-2-6- Analysais of essential oïl

❖ **Gas chromatography analysis**

The essential oil of R. officinalis was analyzed using a Perkin-Elmer gas chromatograph model 2030, fitted with a flame ionization detector (FID) and a HP-5MS capillary column (30 m x 0.25 mm, film thickness 0.25 µm). The temperatures of the injector and detector were set at 40 and 250°C, respectively. The column oven temperature was programmed from 40oC to 300°C at a linear rate of 4 °C min -1 ; initial and final temperatures were held for 3 and 15 min, respectively. Helium was used as a carrier gas at the flow rate of 1.2 mL min -1 . A 1.0 µL sample was injected, using the split mode (split ratio, 1:100). All quantification was done by a built-in data-handling program provided by the manufacturer of the gas chromatograph (Perkin-Elmer, Norwalk, CT, USA). The composition was reported as a relative percentage of

the total peak area. Furthermore, the major components (>10%) were quantified by means of the internal standard addition method.

❖ **Gas chromatography/mass spectrometry analysis**

The essential oil was also analyzed by an Agilent-Technologies (Little Falls, California, USA) 6890N Network gas chromatographic (GC) system, equipped with an Agilent-Technologies 5975 inert XL Mass selective detector and Agilent-Technologies 7683B series auto-injector. Separation of the essential oil chemical constituents was carried out on HP-5 MS capillary column (30 m x 0.25 mm, film thickness 0.25 µm; Little Falls, CA, USA). A 1.0 µL sample volume was injected into the column using the split mode (split ratio 1:100). GC/MS detection was performed by an electron ionization system, with ionization energy of 70 eV. The column oven temperature program was the same as used previously in the GC analysis. The helium was used as carrier gas at a flow rate of 1.5 mL min -1. Mass scanning range was 50 –502 m/z while the injector and MS transfer line temperatures were set at 220 and 300 ºC, respectively**. (Abdullah Ijaz,h and al 2010).**

III-3- Data analysis

The significance of the differences in the results obtained during the evaluation of activities antioxidants of our oils and extracts was carried out by an analysis of variance (ANOVA) and (significance).

General Conclusion

In Algeria, and throughout the world, the growing interest in the use of medicinal plants is motivated by the large number of studies demonstrating their richness in bioactive molecules with therapeutic effects. In this context, our study focused on the species Rosmarinus officinalis, a popular medicinal plant very widespread and widely used in Algeria.

Rosmarinus officinalis L., is a plant used for a long time in traditional medicine. Its anti-oxidant and antimicrobial activities are attributed to its different chemical components (essential oils, flavonoids, polpyhenols, etc.). Rosemary extract contains a massive kind of bioactive molecules with excellent wound healing potential. These include triterpenes (e.g., ursolic and oleanolic acids), tricyclic diterpenes (e.g., carnosic acid and carnosol), phenolic acids (e.g., caffeic acid and rosmarinic acid).

Rosemary oil has received considerable attention in hair because it is said to promote hair growth and prevent hair loss. Rosemary oil is an essential oil obtained from the Rosemary plant.

In recent years there has been growing interest in the use of antioxidants and natural antimicrobials. Many researchers have been interested by biologically active compounds isolated from plant extracts. This work allowed us to evaluate the antioxidant activity of the methanolic extract and the aquous extract and the activity of the essential oil of Rosmarinus officinalis and the antimicrobial activity of the essential oil of Rosmarinus officinalis. We can conclude that:

- The value of the essential oil yield from the aerial part of Rosmarinus officinalis was 1.77%. The yield of the two aqueous and alcoholic extracts were 10.29% and 22.36%, respectively.
- Quantitative determination of total polyphenols by Folin-ciocalteu reagent revealed that rosemary contains a value of (170.85±0.0065 mg Eq G/g, 93.71± 0.0035 mg Eq G/g). for both alcoholic and aqueous extracts respectively.
- The quantitative determination of total flavonoids by the Alcl3 method revealed a value of (17±0.005 mg Eq Q/g. 35± 0.006 mg Eq G/g). for both alcoholic and aqueous extracts respectively.
- The DPPH test results demonstrated anti-radical activity with an IC50 = 31.66±0.03 for the essential oil of rosmarinus officinalic and acis ascorbic 46.22±0.004 ug/ml. a and for the two aqueous and alcoholic extracts a value of (1.13 ±0.71, 2.07±0.89 respectively
- and ascorbic acid with a value (46.22± 0.004).

- The results of the FRAP test We note that the essential oil of rosmarinus officinalis has activity Antioxidant superior to alcoholic extract and aqueous extract.
- The antimicrobial activity of essential oils and aqueous extract of rosemary was evaluated on four bacterial strains and one fungal strain by the Agar diffusion method (well method) Preliminary results show that the aqueous methanolic extract and the extract of rosemary essential oils demonstrate antioxidant and antimicrobial activity in Vitro.
- The essential oils extracted from Rosmarinus officinalis were analyzed by GC/MS to evaluate their composition in total phenols and flavonoids. The extracts were then subjected to HPLC analysis to compare their chromatographic profiles with standards, in particular the alcoholic and aqueous flavonoid extracts. The original sentence mentions that 78 peaks were identified in the spectrum analysis of the essential oil.
- Out of these 78 peaks, 50 compounds were identified and named. The 50 identified compounds account for 98.44% of all the compounds present in the essential oil.The remaining 1.56% of the compounds are considered trace compounds, meaning they are present in very small quantities. The extracts were then subjected to HPLC analysis to compare their chromatographic profiles with standards, in particular the alcoholic and aqueous flavonoid extracts.
- Based on all the results obtained, we could conclude that this plant can be a Natural source of high antioxidant compounds.

Bibliographic reference

- Aafi Abderrahman, 2013. monographie de plantes aromatiques et medicinales du maroc. Rosmarinus officinalis L. Agdal, Rabat. P02.)
- Abdessultane mouna, 2017. Effet du romarin (Rosmarinus officinalis) sur la conservation traditionnelle des dattes dans la région d"adrar. Mémoire master. Universite Ahmed Draia Adrar
- Aboughe Angone, S., Aworet Samseny, R.R.R., et Eyele Mve Mba, C. (2015). Quelques propriétés des huiles essentielles des plantes médicinales du Gabon. Phytothérapie, 13: 283–287.
- Abraham ,E.(2006). Bio-raffinage de plantes aromatiques et médicinales appliqué à l'Hibiscus sabdarifJa L. et à l'Artemisia annua. thèse de doctorat, Toulouse.P:21,23.
- According to Bekkara et al. F. Bekkara, M. Jay, M.R. Viricel, S. Rome, Distribution of phenolic compounds within seed and seedlings of tow Vicia faba cvs differing in their seed tannin content, and study of their seed and root phenolic exudation, Journal Plant and Soil 203 (1998) 27-36.
- According to the method citing in Zhang et al S.Y. Zhang, C.G. Zheng, X.Y. Yan, W.X. Tian, Low concentration of condensed tannins from catechu significantly inhibits fatty acid synthase and growth of MCF-7 cells, Biochemical and Biophysical Research Communications 371 (2008) 654-658.
- Aissaoui l ,2019. Effet de l'utilisation d'un mélange d'huiles essentielles de romarin et de thym sur l'amélioration de la conservation d'un fromage à caillé lactique . (en ligne).Memoire de Master :Production et transformation laitières .Mostaganem :Université Abdelhamid IBn Badis - p118 http://e-biblio.univ-mosta.dz/handle/123456789/12754
- Al Herawi . Muwafaq AL-Din Abu Mansur ALi (1859) , en persan, Al Abniya An HaqaiQ Al Adwiya (350-360 de l'hégire , 971-987) , Teheran : Ed Entesharat Danshgah , 446p .
- American Botanical Council. (2020). Commission E: Rosemary Leaf, http://ems.herbalgram.org/commissione/Monographs/Monograph0319.html, accessed 24 November 2020 and its Mechanisms of Action. Current Pharmaceutical Design, 28(15), 1670-1679.
- Andrade, J.M.; Faustino, C.; García, C.; Ladeiras, D.; Reis, C.P.; Rijo, P. (2018). Rosmarinusofficinalis L.: An update review of its phytochemistry and biological activity Future Sci. OA, 4, 283.

- Andrianomentsoa, B.(2021). Caractérisation et utilisation des huiles essentiales d'HelichrysumfaradifaniScott-Elliot et de Cinnamosmamadagascariensis Danguy obtenus par hydrodistillation avec un alambic automatisé. thèse de doctorat, université d'antananarivo, MADGASCARE.P:17,18.
- Aouad A et Belayachi,2019. Contribution à l'étude de l'activité antimicrobienne de l'extrait hydrométhanolique de Rosmarinus officinalis L. récolté à la région de Naama vis-à-vis de certains germes responsables de toxi-infections alimentaires . (en ligne).Memoire de Master, Université Abdelhamid Ibn Badis Mostaganem- 97p. Disponible sur http://e-biblio.univmosta.dz/bitstream/handle/123456789/13092/memoire%20final%202019.pdf?sequence=1&isAllow ed=y
- Aouati A. (2016). Etude de la toxicité de certaines plantes sur les larves de culex pipiens (Diptera, Culicidae). Thèse de doctorat, Université des frères mentouri. Constantin
- ATHAMENA. S., 2009.Etude quantitative des flavonoïdes des graines de Cuminum cyminum et les feuilles de Rosmarinus officinalis et l'évaluation de l'activité biologique. Mémoire Magister en Biochimie Appliquée. Université El Hadj lakhdar-Batna, pp 56-88.
- Auteur anonyme. Maladies et grands symptômes. Item n°288 : Troubles des phanères. Ann Dermatol Venereol. 2005; 132, 188-91.
- Ayadi, S., Jeribbi, C., et Abderrabba, M. Extraction et étude des huiles essentielles de Rosmarinus Officinalis cueillie dans trois régions différentes de la Tunisie. Journal de la Société Algérienne de Chimie, 2011, vol. 21, no 1, p. 25-33.).
- Badawy M-E. et Abdelgaleil S-A, 2014. Composition and antimicrobial activity of essential oils isolated from Egyptian plants against plant pathogenic bacteria and fungi. Industrial Crops and Products. Vol 52. p 776-782.
- Bakkali F., Averbeck S., Averbeck D.,Idaomar M. (2008). "Biological effects of essential oils–a review." Food and chemical toxicology 46(2): 446-475.
- Begum A., Sandhya S., Ali S.SH.A., Vinod K.R., Reddy S., and Banji D. (2013). An in-depth review on the medicinal flora Rosmarinus officinalis (Lamiaceae). Acta Sci. Pol., Technol. Aliment. 12(1) 61-73.
- Beirão ARB. et Bernardo-Gil MG., 2006. Antioxidants from Lavandula luisieri. 2nd Mercosur Congress on Chemical Engineering. Portugal. 8p.
- Belbey L, (2014). Activité antioxydante de Rosmarinus officinalis L, et soninvitroeffet sur Penicilliumdigitatum . Mémoire de master academique, Université de M'sila.
- Belkhiri F ,2015 .Etude de l'activités antibactérienne des huile essentielles de Rosmarinus officinalis L.(en ligne) Mémoire de Master : Génie des Procédés. Biskra . Université

Mohamed Khider -51pDisponible sur http://archives.univbiskra.dz/bitstream/123456789/6601/1/BELKHIRI.pdf).

- Belloul K et Chouiref M,2016 . Etude de l'activité antioxydante d'une plante médicinale (le romarin). (en ligne).Mémoire de Master: Génie chimique .Universite Echahid Hamma Lakhdar - El oued -666 p. Disponible sur http://e-biblio.univ-mosta.dz/handle/123456789/13092
- Benbelaid F. (2015). Effets des huiles essentielles de quelques plantes aromatiques sur Enterococcus faecalis responsable d'infections d'origine dentaire Université de Tlemcen Algeria.
- Benbelaïd F., Khadir A., Abdoune M. A., Bendahou M., Muselli A.,Costa J. (2014). "Antimicrobial activity of some essential oils against oral multidrug–resistant Enterococcus faecalis in both planktonic and biofilm state." Asian Pacific journal of tropical biomedicine 4(6): 463-472.
- Benikhlef A, (2014).Comparaissant entre les huiles essentielles et leurs effets antibactériens sur Rosmarinus officinalis de la région de Bechar et Ouargla . Mémoire de master. Université Abor Belkaid-Tlemcen.
- Bentabet L, N. (2014). Etude phytochimique et évaluation des activites biologiques de deux plantes Fredoliaaretioides et Echiumvulgare de l'ouest Algerien. These Doctorat en biologie. Université Abou BekrBelkaid, Tlemcen. Algérie.162p:2.
- Benzineb zoulikha, 2019. Effets antimicrobiens des extraits de romarin (Rosmarinus officinalis) sur les qualité phisico-chimique et microbiologique d"un lait fermenté yaourt. Mémoire master. Université Abdelhamid ibn badis. Mostaganem. Pp15-16
- Berkane A. (2015). La détermination des propriétés thermodynamiques d'huile essentielle de Rosmarinus Officinalis L. Mémoire de Fin d'Etudes Pour l'obtention de diplôme Master, Université Djilali Bounaama - Khemis Miliana.
- Bernard BA. The life of human health follicule. M/S: Medicine sciences 2006; 22 (2): 138-143. [In the link] Site.org/iderudit/ 012381ar-Avril 2012.
- Bernard Bruno A. La vie révélée du follicule du cheveu humain. Medecine sciences. 2006 ; 22 : 138-43.
- Berramdani A et Baghdadi M , 2021 . Évaluation de L'effet anti-inflammatoire et antidépresseurs des huiles essentielles de Rosmarinus officinalis.(en ligne) Mémoire de Master: Biochimie Appliquée. Biskra. Université Mohamed khlder de Biskra-p36 .Disponible sur :http://archives.univbiskra.dz › ...PDF 36.

- Bettahar C et Chekalil S, 2020. Etude biologique de huile essentielle de Rosmarinus officinalis de la wilaya de Ain defla .Mémoire de Master: Microbiologie appliquée. Khemis Miliana : Université Djillali Bounaâma -p35 Disponible sur : http://hdl.handle.net/123456789/3726.
- Boigny, Côte *Boukhatem Mohamed Nadjib, Ferhat Amine et Kameli Abdelkrim. (2019). Méthodes D'extraction et de Distillation des huiles essentielles : Revue de Littératue
- Bonev, B., J. Hooper, and J. Parisot, Principles of assessing bacterial susceptibility to antibiotics using the agar diffusion method. Journal of antimicrobial chemotherapy, 2008. 61(6): p. 1295-1301.
- Bottineau M, 2010. Botanique systématique et appliquée des plantes à fleurs. Ed TEC&DOC, Lavoisier, Paris. P : 1021-1043
- Bouadjmi K,2018 .Etude comparative des différents parties de la plante romarin «Rosmarinus officinalis» par rapport aux pouvoirs antibiotiques sur le yaourt(en ligne) .Mémoire de Master :Biotechnologie Alimentaire. Mostaganem :Université Abdelhamid Ibn Badis-68p Disponible sur mosta.dz/handle/123456789/4263-biblio.univ-http://e.
- Boubrit S .,Boussad N ,Determination "in vitro " du pouvoir antibacterien des huiles essentielles d'eucalyptus, myrte, clous de girofle et sarriette, et leur application à la conservation de la viande fraà®che type hachee, Biologie et Médecin, Tizi-ouzou : Université Mouloud Mammeri, 2007).
- Boudgebir K,2017,Evaluation de l'activité antimicrobienne de deux huiles essentielles Rosmarinus officinalis et Cymbopogon citratus en perspective de leurs utilisation comme conservateur de denrées alimentaires(en ligne).Mémoire de Master : Microbiologie et Toxicologie Alimentaire.Blida -:Université Blida - 150 p Disponible sur https://www.theses-algerie.com › ev.
- Bouhanna P. Les alopécies de la clinique au traitement. France : Edition MED'COM). (Jean Laudereau. Pour une meilleure connaissance du cheveu. 7ème édition. Italie ; 1995.
- Bouhanna P. Les alopécies de la clinique au traitement. France : Edition MED'COM.
- Bouhanna P. Soigner and préserver ses cheveux. France: Alpen Edition; 2006.
- Bouhdid S., Abrini J., Baudoux D., Manresa A.,Zhiri A. (2012). "Les huiles essentielles de l'origan compact et de la cannelle de Ceylan: pouvoir antibactérien et mécanisme d'action." Journal de Pharmacie Clinique 31(3): 141-148.
- Boukhatem et al.,Méthodes d'extraction et de distillation des huiles essentielles: Revue Agrobiologia(2019).

- Boulazazen, (2017)Evaluation de l'activité antioxydante et antimicrobienne d'une plante aromatique (RosmarinusOfficinalis L.) De la forêt Béni Melloul –Khenchela ,memoir de master p39.
- BOULEZAZEN,A.(2017) . Evaluation de l'activité antioxydante et antimicrobienne d'une plante aromatique (Rosmarinus Officinalis L.) de la forêt Béni Melloul –Khenchela, Université El chahid Hamma Lakhder El-oued,P 8 ,9,10.
- Boumadjen R (2018), Etudephytochimique et evaluation de l'activité antioxydantede Romarin (Rosmarinusofficinalis), memoire de master, P44
- Boumadjen Roufeida, Kimouche Sara, 2018. Etude phytochimique et evaluation de l"activité antioxydante de Romarin (Rosmarinus officinalis). Memoire master. Université Frères Mentouri Constantine. Pp26-30
- Bourahlla N ,Halfaya A et Khelif O ,2020.Étude de l'effet antibactérien de l'huile essentielle d'une plante médicinale (Euca-lyptus camaldulensis) .(en ligne)Memoire de Master: Microbiologie appliquée .Tébessa :Université de Larbi Tébessi. Disponible sur http://dspace.univtebessa.dz › ...PDFMEMOIRE de fin d'étude .
- Bourita A et Boubelli K ,2017. Étude de l'activité antibactérienne d'huile essentielle de Rosmarinus officinalis cultivée à Jijel .(en ligne) Mémoire de Master: Microorganismes et pathogénécité.Jijel:Université Mohamed Seddik Ben Yahia-p42 .Disponible sur http://dspace.univjijel.dz ›.
- Bourrain J. (2013). "Allergies aux huiles essentielles: aspects pratiques." Revue Française d'Allergologie 53: 30-32.
- Bousbia B et Souaci W ,2021.Enquête ethnobotanique et étude photochimique de deux plantes médicinales (Rosmarinus officinalis et Juniperus phoenicea) dans la région d'Oued Souf(en ligne) . Mémoire de Master : Biodiversité et environement.El oued :Université Echahid Hamma Lakdhar151p. Disponible sur : http://dspace.univ-eloued.dz/handle/123456789/10032
- Bousbia,N.(2011).Extraction des huiles essentielles riches en anti-oxydants à partir de produits naturels et de co-produits agroalimentaires. Thèse de doctorat. Université d'Avignon, France .P: 16.
- BOUTABIA. L; TELAILIA. S; BOUGUETOF. I; GUENADIL. F; CHEFROUR. A., 2016.Composition chimique et activité antibactérienne des huiles essentielles de RosmarinusofficinalisL.de la région de Hammamet (Tébessa-Algérie). Journal of Bulletin de la Société Royale des Sciences de Liège, 85, 174-189.

- BOUTKEDJIRT. C; BELABBES. R; BENTAHAR. F; BESSIERE. M.J., 1998. The Essential Oil from Rosmarinus officinalis L. in Algeria. Journal of Essential Oil Research, 10, 680-682.
- Boutoial, K., Ferrandini, E., Rovira, S., García, V., & López, M. B. (2013). Effect of feeding goats with rosemary (Rosmarinus officinalis spp.) byproduct on milk and cheese properties. Small Ruminant Research, 112, 147–153.).
- Boutoial, K., Ferrandini, E., Rovira, S., García, V., & López, M. B. (2013). Effect of feeding goats with rosemary (Rosmarinus officinalis spp.) byproduct on milk and cheese properties. Small Ruminant Research, 112, 147–153.
- Budavari.s, M. J. O'Neil, A. Smith and P. E. Heckelman, "The Merck Index, an Encyclopedia of Chemicals, Drugs, and Biologicals," 11th Edition, Merck & Co, Whitehouse Station, 2001.
- Calixto JB. (2005). Twenty-five years of research on medicinal plants in Latin America: a personal view. J. Ethnopharmacol. 100(1–2), 131–134.
- Calvo MI, Akerreta S, Cavero RY. (2011); Pharmaceutical ethnobotany in the Riverside of Navarra (Iberian Peninsula). J. Ethnopharmacol. 135(1), 22–33 (2011).Crossref, Medline, CAS, Google Scholar
- Cazzola, C., & Doublet, C., 2015. Mise au point d'une technique de séparation et de quantification des composés présents dans une huile essentielle. Rapport PE huiles essentielles, projet de l'Institut National des Sciences Appliquées de Rouen (INSA). p.p. 13-14.
- Centre clauderer web site – URL: http://www.centre-clauderer.com - Octobre 2012.
- Chafai elalaoui ali, Boukil ahmed, Bachar mohamed, Driss lkhoumsi, Guermal abdenasser et Aafi abderrahman, 2014. Manuel des bonnes pratiques de collecte du Romarin (Rosmarinus officinalis). Agdal-Rabat. P03.
- Chelaghema,A.(2021). Utilisation d'extraits végétaux pour la maîtrise du risque mycotoxique dans les systèmes agro-alimentaires. Toxicologie et chaîne alimentaire. Thèse de doctorat. Université Montpellier. Français. P:57.
- Chibah R et Labandji A , 2017.Extraction et caractérisation des huiles essentielles de Rosmari-nus officinalis et l'étude de quelques activités biologiques(en ligne) .Memoire de Master : Analyses biologiques et biochimiques. Boira :Universite Akli Mohand Oulhadi - 53p .Disponible sur : https://www.theses-algerie.com/2712527695654372/memoire-de-master/universite-akli-mohandoulhadj-bouira/extraction-et-caracterisation-des-huiles-essentielles-de-rosmarinus-officinalis-etletude-de-quelques-activites-biologiques

- Chir. Dermatologie. 98-020-A-10, 6p
- Chorfi, A.et Sid,M.(2022). Etude de l'activité antioxydante des huiles essentielles de trois plantes aromatiques médicinales d'Algérie (Artemisia herba alba, Rutamontanaet Mentharotundifolia). Mémoire de master, Université L'Arbi Ben M'Hidi, Oum-El Bouaghi .P:8,13.
- Chouikh, M. Mekki, E.H. Adjal, Effects of extraction methods on antibacterial activity of different extracts of Calligonum comosum L'her. Growing in SaharaAlgerian, International Journal of Recent Scientific Research 6 (2015) 3534 3536 .
- D'une plante aromatique (RosmarinusOfficinalis L.) De la forêt Béni Melloul –Khenchla ,memoir de master LMD, P35.
- Deschepper,R.(2017). Variabilité de la composition des huiles essentielles et intérêt de la notion de chémotype en aromathérapie. Thèse de doctorat, université de marseille.P:11,14.
- Dif, M., Benali-Toumi, F., Benyahia, M., et BecheikhiLhuillier A. 2007 Contribution à l'étude phytochimique de quatre plantes malgaches: Agauria salicifolia Hook.f ex Oliver, Agauria polyphylla Baker (Ericaceae), Tambourissa trichophylla Baker (Monimiaceae) et Embelia concinna Baker (Myrsinaceae). Thèse de doctorat. Toulouse.
- Djebbari H ,Barki D ,Boumaagouda S ,2021.Étude de l'effet antibactérien de l'huile essentielle de deux plantes médicinales (Rosmarinu,s officinalis et Eucalaptus camaldulensis(en ligne) .Memoire de Master : Microbiologie apliquée. Tébessa :Université de Larbi Tébessi -64p .Disponible sur : http//localhost:8080/jspui/handle/123456789/807.
- Djerrad, Z., Kadik, L., and Djouahri, A. (2015). Chemical variability and antioxidant activities among Pinus halepensis Mill. essential oils provenances, depending on geographic variation and environmental conditions. Ind. Crops Prod, 74: 440–449.
- Djouahri, A., Boudarene, L., and Meklati, B.Y. (2013). Effect of extraction method on chemical composition, antioxidant and anti-inflammatory activities of essential oil from the leaves of Algerian. Ind. Crops Prod, 44: 32–36.
- Dominique mansion, Jean-claudeRameau, Gérard dumé, Christian gauberville, Jacques bardat, Eric bruno et René keller, 2008. Flore forestièrefrançaise tome 3 Guide écologiqueillustrérégion méditerranéenne. P897.
- Dorman, H.J.D., Peltoketo, A., Hiltunen, R., Tikkanen, M.J. (2003); Characterisation of the antioxidant properties of de-odourised aqueous extracts from selected Lamiaceae herbs. Food Chem. 83: 255-262. Dworkin MM and Falkow S. Proteobacteria:

- Doukkali L, Tahiri A, Tazi B et Guenoun F, 2018. Chemical Composition and Antibacterial Activity of two Essential Oils rosemary Against Erwinia amylovora the causal agent fire blight. Journal of Materials and Environmental Sciences. Vol 5, n°10. p 2913-2918.
- Echchaou M , 2018. Pouvoir antibactérienne des huiles essentielles(en ligne).Thèse de Doctorat : Pharmacie. Rabat : Université de Mohammed V ,138P .Disponible sur :http://hdl.handle.net/123456789/16429(page consulter le 20/12/2021.
- édition med'com ; 2010.
- El Amri J., Elbadaoui K., Zair T., Bouharb H., Chakir S.,Alaoui T. (2014). "Étude de l'activité antibactérienne des huiles essentielles de Teucrium capitatium L et l'extrait de Siléne vulgaris sur différentes souches testées." Journal of Applied Biosciences 82(1): 74817492.).
- El haib , A. (2011). Valorisation de terpènes naturels issus de plantes marocaines par transformation catalytique. Thèse de doctorat, université Toulouse III – Paul Sabatier.P:5.
- Elizabeth I .(2021) ; LIVRE / Culinary Herbs and Spices A Global Guide, Par Elizabeth I. Opara, Magali Chohan • 2021Date de publication originale : 30 juillet 2021, Genres : Encyclopédie, Livre de cuisine Nombre de pages : 604.
- Erkan, N., Ayranci, G., Ayranci, E. (2008); Antioxidant activities of rosemary (Rosmarinus Officinalis L.). Extract, blackseed (Nigella sativa L.) essential oil,carnosic acid, rosmarinic acid and sesamol. Food Chem. 110: 76-82.
- Es- Safi N. E., Kolllmann L., Khlifi S. et Ducrot P.H. 2007. Antioxydants effect of compounds isolated from Globulairia alypum L Structure-activity relationship. LWT-Food sience and technology., 40 :1246-1252.
- EZZIAT H ,(2013), Etude comparative des huiles essentielles de Rosmarinusofficinalis L. de deux provenances (Blida et Djelfa).Memoire de master , P 33 .
- Ezziat H,2013 . Etude comparative des huiles essentielles de Rosmarinus officinalis L. de deux provenances (Blida et Djelfa) (en ligne) .Mémoire de Master: Biotechnologie Vegetale .Blida 1.Universite Saad Dahleb de Blida.Disponible sur : http://di.univ-blida.dz:8080/jspui/handle/123456789/10413
- Falleh H., Ksouri, R., Chaieb, K., Karray-Bouraoui, N., Trabelsi, N., Boulaaba, M., Abdelly, C. (2008); Phenolic composition of Cynara cardunculus L. organs, and their biological activities .C. R. Biologies. 331: 372-379 .

- Fery Hue, F, (1997). Le romarin et ses propriétés. Un traité anonyme faussement attribué à Aldebrandin de Sienne [article] sem-linkFrançoise Fery-Hue Romania Année 1997 ,457-458 pp. 138- 192
- Franbourg A, Hallegot P, Baltenneck F, Toutain C and Leroy F. Current research on ethnic hair. J Am Acad Dermatol, 2003, 48(6 Suppl):S115-S119.
- Gardeli, C., Pagageorgiou, V., Mallouchos, A., Theodosis, K., and Komaitis, M. (2008). Essentail oil composition of Pistacia lentiscus L. and Myrtus communis L: Evaluation of antioxidant capacity of methanolic extracts. Food chemistry, 107: 1120- 1130.
- Garnier, S.(2020). L'aromathérapie dans le traitement des pathologies respiratoires hivernales. Thèse de doctorat. Universite Clermont auvergne, France. P:57,59.
- Gherib M. (2009). Etude des activités antimicrobienne et antioxydante des huiles essentielle et des flavonoides d'Artemisia herba alba Asso; Artemisia judaica .L. ssp. sahariensis; Artemisia campestris L; HerniariamauritanicaMurb et Warioniasaharae Benth. et Cou. Thèse de Magister de l'université Abou BekrBelkaid sTlemcen.109P
- Goetz P et Ghedira K, 2012. Phytothérapie anti-infectieuse. Ed Springer Verlag France, Paris. p 342-345.
- Goetz P.,Ghedira K. (2012). Phytothérapie anti-infectieuse, Springer Jain H., Mulay S.,Mullany P. (2016). "Persistence of endodontic infection and Enterococcus faecalis: Role of horizontal gene transfer." Gene reports 5: 112-116.
- Guermit A, Rhaim F. (2019). Contribution à l'étude de la toxicité de deux plantes médicinales (Rosmarinus officinalis et Artemisia herba alba) sur les larves de culicidées dans la région de Oued souf. Mémoire de fin d'etude en vue de l'obtention du diplôme de Master Académique en Sciences biologiques. Université Echahid Hamma Lakhdar El – OUED.
- Haloui, M., Louedec, L., Michel, J.B. and Lyoussi, B. (2000). Experimental diuretic effects of Rosmarinus officinalis and Centaurium erythraea. Journal of ethnopharmacology, 71(3), 465- 472.
- Hamedo, H. A. and Abdelmigid, H. M. (2009). Use of antimicrobial and genotoxicity potentiality for evaluation of essential oils as food preservatives. The Open Biotechnology Journal, 3
- Haouam, M. T. (2019). Évaluation de l'activité biologique de l'huile essentielle extraite à partir du Romarin (Doctoral dissertation, Universitelaarbitebessitebessa.
- Hargaran, S., & Sood, S. (2022). Understanding Essential Oils for Hair Growth

- Herzi ,N.(2013). Extraction et purification de substances naturelles : comparaison de,l'extraction au CO2-supercritique et des techniques conventionnelles. Thèse de doctorat. Universite de toulous. P:15.
- Hillmann K, Garcia Bartels N, et al. A randomized, double-blind, placebo-controlled trial of rosemary oil in the treatment of androgenetic alopecia. J Am Acad Dermatol.2011 Dec;65(6):1126-1134.e2. doi: 10.1016/j.jaad.2010.09.724.

- Histologie de la peau et des follicules pileux », Catherine Prost-Squarcioni M/S : médecine sciences, vol. 22, n° 2, 2006, p. 131-137.
- Ho, S.C Ferhat M. (2009); Recherche de substances bio actives de Centaureamicrocarpacoss et dur. Diplôme étude supérieur de biochimie Université de M'sila .
- Hussain AI., Anwar F., Ali Shahid S., Mahboob S., Nigam PS. Rosmarinus Officinalis essential oil: antiproliferative, antioxidant and antibacterial activities. brazilian journal of microbiology 2010 ; 41 :1070-1078.
- Ibtissam LAIB, Ali Boutlilis Djahra (2023), PHENOLIC COMPOUND PROFILE AND EVALUATION OF BIOLOGICAL ACTIVITIES OF THE CRUDE EXTRACT AND SOME BIOACTIVE COMPOUNDS OF Helianthemum lippii AERIAL PARTS, article Analele Universităţii din Oradea, Fascicula Biologie, P118.
- Image : comparaison des écailles de la cuticule d'un cheveu web-site – URL : http://beautiful-boucles.com/ouvrir-les-cuticules-pour-mieux-faire-penetrer-les-actifs-dansses-cheveux-une-f.
- Image : Les trois types de cheveux dans le monde web-site-URL : http://deko.apshram.net/illustraworld/dessin_pay.php?lang=FR&back=72,87,413.
- Image : Schéma détaillé d'un follicule pilo-sébacé.URL : http://theses.ulaval.ca/archime de/fichiers/22895/ch01.html.
- Image: Cross section of a hair web site- URL: http://beautistas.com/beauty base/cheveux.
- Image: from a hair to a keratin molecule web-site – URL: http://tpe-ace.e monsite.com/pages/structure-et-composition-du-cheveu.htm.
- Jaubert, J. N. (2005). Les odeurs dans l'air: de la pollution osmique à la gêne olfactive. Environnement, Risques& Santé, 4(1), 51-61).
- Jean Laudereau. Pour une meilleure connaissance du cheveu. 7ème édition. Italie ; 1995.

- Juhas, S., Bukovska, A., Cikos, S., Czikkova, S., Fabian, D., Koppel, J.(2009) ; Antiinflammatory effects of Rosmarinus officinalis essential oil in mice. Acta Vet. Brno 78, 121–127.
- JUSTESEN. U; KNUTHSEN. P., 2001.Compsition of flavonoids in fresh herbs and calculations of flavonoid intake by use of herbs in traditional Danish dishes. Journal of Food Chemistry, 73, 245-250.
- Kaoune,A et Chabane,F.(2017). Contribution à l'étude des activités antibactérienne etantioxydante de l'huile essentielle de l'Armoise blanche (Artemesia herba alba). Mémoire de master. Université Mouloud Mammeri ,Tizi-Ouzou. P:5-33.).
- Keraifi,F et boualam,K.(2021).Extraction et caractérisation de quelques huiles essentielles des plantes Utilisés dans la thérapie grippale (Thymus lanceolatus, Eucalyptus globulus). Mémoire de master. Université MohamedKhider , Biskra. P:16
- Khebri S. (2011). Etude chimique et biologique des huiles essentielles de trois Artemisia . Thèse de Magister de l'université El-hadj Lakhdar ŔBatna.103p.
- Kiehlbauch, J.A., et al., Use of the National Committee for Clinical Laboratory Standards guidelines for disk diffusion susceptibility testing in New York state laboratories. Journal of clinical microbiology, 2000. 38(9): p. 3341-3348.
- Kim, S.Y., Jeong, S.M., Park, W.P., Nam, K.C., Ahn, D.U., and Lee S.C. (2006). Effect of heating conditions of grape seeds on the antioxidant activity of grape seed extracts. Food chemistry, 97: 472-479.
- Korner, C. (2007). The use of 'altitude' in ecological research. Trends Ecol. Evol, 22: 11.
- Labiod R ,2016. Valorisation des huiles essentielles et des extraits de Satureja calamintha nepeta : activité antibactérienne, activité antioxydante et activité fongicide.(en ligne).These doctorat : Biochimie appliquée. Annaba :Universite Badji Mokhtar-128P.Disponible sur : https://www.univsoukahras.dz/eprints/2016-9175-fa163.
- Laetitia.(2015). Utilisation des huiles essentiales chez l'enfant. Thèse de doctorat Université d'auvergne, France. P:39,42.
- Lagsier O et Nadir N ,2020.Evaluation du potentiel aphicide de " Rosmarinus officinalis" sur les pu-ceron des céréales Rhopalosiphum Maidis (en ligne) Mémoire de Master :Biodiversité et Environne-ment.El-Oued : Université Echahid Hamma Lakhdar -90p .Disponible sur :http://dspace.univ-eloued.dz/bitstream/123456789/7615/1/574.01.096
- Langbein L, Rogers MA, Winter H, Praetzel S and Schweizer J. the catalog of human hair keratins. II. Expression of the six type II members in the hair follicule and the combined catalog of human type I and II keratins. J Biol Chem, 2001, 276:35123-35132.

- Laraba et al.,(2016). Etude in vitro de l'activité antioxydante des polyphénolsisolés à partir d'une plante médicinale. Mémoire de master. Université des Frères Mentouri ,Constantine.P:41.
- Lucchesi,M.(2005). Extraction Sans Solvant Assistée par Micro-ondes Conception et Application à l'extraction des huiles essentielles. Autre. Thèse de doctorat. Université de la Réunion,. Français. P:16.
- Maaoui moufida, 2014. Atlas plantes ornementales plantes ornementales des Ziban. Bisekra.
- Makhloufi A., 2009- Etude des activités antimicrobienne et antioxydante de deux plantes médicinales poussant à l'état spontané dans la région de bechar(Matricaria pubescens (Desf.) et Rosmarinus officinalis L) et leur impact sur la conservation des dattes et du beurre cru. Mémoire doctorat. Université Aboubaker Belkaid Bechar, 136p
- Mansouri F Z, Messabhia H. (2018). Etude de l'effet larvicide de l'extrait hydroalcoolique de Rosmarinus officinalis à l'égard deCulex pipiens. Mémoire de master, Université Larbi Ben M'Hidi Oum El Bouaghi
- Mansouri, A., Embarek, G., Kokkalou, E., & Kefalas, P. (2005). Phenolic profile and antioxidant activity of the Algerian ripe date palm fruit (Phoenix dactylifera). Food Chemistry, 89(3), 411-420.
- Marion L,2017.Le Romarin , Rosmarinus officinalis L. , une Lamiacée médicinale de la garrigue provençale (en ligne) . Thèse Doctorat . : Pharmacie. Marseille : Faculté de Pharmacie Aix - p229Disponible sur : https://dumas.ccsd.cnrs.fr › dumas-0.
- Martos, M.V., Navajas, Y.R., Zapata, E.S., Lopez, J.F., and Alvarez, J.A.P. (2009). Antioxidant activity of essential oils of five spice plants widely used in a Mediterranean diet. Flavour Fragr. J, 25:13–19.
- Mathias M., 2008- Filière plantes aromatique et à parfum. Fiche technique de Lycée Agricole de Rivesaltes, 8p
- Mehani M ,2015. Activité antimicrobienne des huiles essentielles d'Eucalyptus camaldulensis dans la région d'Ouargla. (En ligne). Thèse de Doctorat: Microbiologie. Ouargla : Faculté des Sciences de la Nature et de la Vie -170 p..Disponible sur : https://dspace.univouargla.dz/jspui/handle/123456789/8995
- Mehani,2015. UNIVERSITE KASDI MERBAH – OUARGLA, Activité antimicrobienne des huiles essentielles d'Eucalyptus camendulensis dans la région de Ouargla,P47.
- Melissopoulos A et Levacher C. Les annexes cutanées. Dans : La peau : structure et physiologie, édition Lavoisier ; 1998. p. 57-99.

- Menaceur,F.(2015). Contribution à l'étude phytochimique et biologique de l'érigeron, du fenouil commun, de la lavande et du genévrier. Thèse de doctorat, école national supérieur agronomique El-HARRACH –ALGER. P:10,25.
- Merghache S., Hamza M et Tabti B. (2009). Etude physicochimique de l'huile essentielle de Ruta Chalepensis L. de Tlemcen, Algérie. Afrique Science 05(1). p 67-81. ISSN 1813-548X Pennsylvania State University Press, University Park.
- Mnayer, D. (2014). Eco-Extraction des huiles essentielles et des arômes alimentaires en vue d'une application comme agents antioxydants et antimicrobiens. Université d'Avignon, Français .P:5,7.
- Moghtader, M., and Afzali, D. (2009). Study of the antimicrobial proprieties of the oil of Rosemary. Am. Eurasian J. Agric. Environ. Sci, 5 (3): 393–397.
- Molinari E, Chosidow O. La dermite séborrhéique de la clinique au traitement. France :
- Mostefai A., 2012- Contribution à une étude morphométrique de Rosmarinus officinalis L (Lamiacées) dans la région de Tlemcen. Mémoire Master. Université Abou beker Belkaid, 100p
- Mostefai, A. ; Stambouli-Meziane, H. ; Bouazza, M. (2015). Therapeutic use of Rosmarinus officinalis L. (Lamiales Lamiaceae) and description of its medicinal flora cortege in Algeria. Laboratory of Ecology and Management of Natural Ecosystems, P.O. Box 296, 13000 Tlemcen, Algiers, Algeria. Journal article :Biodiversity Journal ; Vol.6 No.3 pp.761-766 ref.14.
- Murata, K.; Noguchi, K.; Kondo, M.; Onishi, M.; Watanabe, N.; Okamura, K.; Matsuda, H. (2013). Promotion of Hair Growth by Rosmarinus officinalis Leaf Extract. Phytother. Res., 27, 212– 217.)
- Murugan, R., & Parimelazhagan, T. (2014). Comparative evaluation of different extraction methods for antioxidant and anti-inflammatory properties from Osbeckia parvifolia Arn.– An in vitro approac h. Journal of King Saud University-Science, 26(4), 267-275.
- Naab D et Hadibi S,2018 .Evaluation de l'activité antimicrobienne des deux huiles essentielles Zingiber officinale et Rosmarinus officinalis en combinaison avec la nisine - 101p. (en ligne) .Mémoire de Master:Biotechnologie microbienne.TIizi - Ouzou .Universite Mouloud Mammeri .Disponible sur : http://agrobiologia.net/online/performances-de-croissance-en-pre-sevrage-deschevreaux-de-la-race-alpine-eleves-dans-les-conditions-arides-du-sud-est-algerien/ aissaoi.

- Naggar .Mustapha, Iharchine. Khalid . (2015). Pour une valorisation durable des produits forestiers non ligneux : cas des facies à romarin de l'Oriental (Maroc), XIVeme CONGRES FORESTIER MONDIAL, FAO, Durban, Afrique du Sud, 7-11 .
- Nogata, Y., Sakamoto, K., Shiratsuchi, H., Ishii, T., Yano, M., Ohto, H. (2006). Flavonoid composition of fruit tissues of citrus species. Bioscience, Biotechnology and 1349 Biochemistry, 70, 178-192. 146. Northcote.R. (1903). The Book of Herbs, John Lane : The Bodley Head, London and New York
- Oraiza, M. (1986). Studies on product of browning reaction prepared from glucosamine. Japanese J Nutr, 44, 307-315.
- Ouibrahim Amira, 2015. Evaluation de l"effet antimicrobien et antioxydant de trois plantes aromatiques (Laurus nobilis L., Ocimum basilicum L. et Rosmarinus officinalis L.) de l"est Algérien. Thèse doctorat. Universite Badji Mokhtar - Annaba. P07.
- Outaleb, (2016),xtraits de romarin d'Algérie (Rosmarinusofficinalis L. et Rosmarinustournefortii De Noe) : Analyse chimique et activités antioxydantes et antimicrobienne, memoir de master LMD, P70.
- Panahi, Y., Taghizadeh, M., Marzony, E. T., & Sahebkar, A. (2015). Rosemary oil vs minoxidil 2% for the treatment of androgenetic alopecia: a randomized comparative trial [Abstract]. Skinmed, 13(1), 15-21.
- Pandey A-K, Kumar P, Singh P, Tripathi N-N et Bajpai V-K, 2017. Essential oils: Sources of antimicrobials and food preservatives. Frontiers in microbiology. Vol 7. p 2161.
- paprikaetchocolat.wordpress.com
- Parthasarathy, V. A., Chempakam, B., Zachariah, T. J. (2008). Chemistry of spices. Édition CABI, Londres, Royaume-Uni.).
- Pierard-Franchimont C, Pierard GE. Physiologie de la sécrétion sébacée. Encycl. Méd.
- Piochon,M.(2008).Étude des huiles essentielles d'espéces végétales de la flore laurentienne : composition chimiques , activités pharmacologiques et hémi-synthèse . Mémoire.Université du Québec à Chicoutimi. P:7.
- Podsedek, A. (2007); Natural antioxidants and antioxidant capacity of Brassica vegetables: A review. LWT, 40:1-11. Percival SL. Microbiology of waterborne diseases. Ed. Elsevier Academic Press, Amsterdam; Boston, 2004, p. 480. Ponce A.G., Fritz R., del Valle C. &Roura S.I., (2003).
- Poils et cheveux – Canalblog : storage.canalblog.com/39/52/626667/41278181.pdf.

- Rafie Hamidpour, Soheila Hamidpour , and Grant Elias (2017), Rosmarinus Officinalis (Rosemary): A Novel Therapeutic Agent for Antioxidant, Antimicrobial, Anticancer, Antidiabetic, Antidepressant, Neuroprotective, AntiInflammatory, and Anti-Obesity Treatmen Biomed J Sci & Tech Res.P 1101.
- Reisch, C., Anke, A., and Rohl, M. (2005). Molecular variation within and between ten provenances of Primula farinosa (Primulaceae) along an altitudinal gradient in the northern Alps. Basic Appl. Ecol, 6: 35–45.
- Rutuja P. Khairnar*, Shubhdha B. Dube, Rutuja N. Pinjarkar, Rutuja B. Aher,(2023)Rosmarinus Officinalis L. : Used for the Treatment of Hair Loss, INTERNATIONAL JOURNAL IN PHARMACEUTICAL SCIENCES Journal Homepage: https://www.ijpsjournal.com P527.
- Saihi R. (2011). Etude phytochimique, Extraction des produits actifs de la plante Artemisia campestris de la région de Djelfa. Mise en évidence de l'activité biologique.Mémoire Magister: Chimie Organique. Oran: Université d'Oran, 20-21.
- Sayorwan.W, Ruangrungsi.N , Piriyapunyporn.T , Hongratanawor akit.T , Kotchabhakdi.N and Siripornpanich.V. (2013). Sci. Pharm , 81, 531-542
- Senouci ,H.(2020). « Etude des activités biologiques de l'huile essentielle de Ammoidesverticillata, en combinaison avec les huiles essentielles de Curcuma longaet Allium sativumet Micro- encapsulation de l'HE de Ammoidesverticillataen vue d'une lutte biologique ». Thèse de doctorat, université AboubakrBelkAid, Tlemcen.P:20.
- Serigne et al . Evaluation de l'activité anti oxydante des extraitshydro-ethanoliques des feuilles et écorces de PiliostigmathonningiiSchumach(2017).p :771.
- Serrato-Valenti, G., Bisio, A., Cornara, L., Ciarallo, G. (1997). Structural and histochemical investigation of the glandular trichomes of Salvia aurea L. leaves, and chemical analysis of the essential oil. Annals of Botany, 79(3), 329-336).
- Slougui, N., Mahfoud, H. M. (2017). Etude analytique comparative des huiles essentielles de quelques variétés de basilic cultivées pour la première fois dans diverses régions d'Algérie,Thèse de doctorat. UniversitéKasdiMerbah-Ouargla.
- Soufit D, Bennaceur K. (2014). Evaluation de l'activité antioxydante de l'extrait méthanolique et l'activité Antimicrobienne des huiles essentielles de Rosmarinus officinalis. (Mémoire de master, Université Abderrahmane Mira de Bejaïa). P20.
- Tayeb Cherif et Menacer ,2016 .L'activité antibactérienne des huiles essentielles du Rosmarinus officinalis et de Origanum vulgare sur la bactérie E.coli (en ligne) .Mémoire de Master:Génétique moléculaire universitaire -34p Disponible sur :

https://fac.umc.edu.dz/snv/faculte/biblio/mmf/2017/L%E2%80%99activit%C3%A9%20antibact%C
3%A9rienne%20des%20huiles%20essentielles%20du%20Rosmarinus%20officinalis%20et%20de %20Origanum%20vulgare%20sur%20la%20bact%C3%A9rie%20E.coli.pdf.

- The British Pharmacopoeia ,(2019) . Commission Secretariat of the Medicines and Healthcare Products Regulatory Agency (MHRA), The British Pharma- copoeia, TSO (The Stationery Office), Printed edn, 2019
- The study of hair. Walsh William J. URL: http://www.cengagesites.com/academic/assets/sites/4827/chapter3_bertino.pdf.
- Toure, D. (2015). Etudes chimique et biologique des huiles essentielles de quatre plantes aromatiques medicinales de côte d'ivoire. Thése de Doctorat. Université Felix Houphoeut
- TPE Cheveux raides ou frisés : http://tpecheveuxraidesoufrises.e-monsite.com/ .
- Tsai, P., Tsai, T., Ho, S. (2007), in vitro inhibitory effects of rosemary extracts on growth and glucosyltransferase activity of Streptococcus sobrinus. Food Chem. (in press .
- Tu Z, Moss-Pierce T, Ford P, Jiang TA. (2013). Rosemary (Rosmarinus officinalis L.) extract regulates glucose and lipid metabolism by activating AMPK and PPAR pathways in HepG2 cells. J. Agric. Food Chem. 61(11), 2803–2810. Crossref, Medline, CAS, Google Scholar
- Tulok, M.H., Hegedus, A., Renner, C., SzollosiVarga, I. (2003); Antioxidant effect of various rosemary (Rosmarinus officinalis L.) clones+. Acta BiologicaSzegediensis. 47:111
- Ullmann.h.f., 2005 botanica
- Upadhyay. S., Kapil Bisht, Amit Bahukhandi, Monika Bisht, Poonam Mehta, Arti Bisht. (2021). Rosmarinus officinalis L, Naturally Occurring Chemicals Against Alzheimer's Disease , academic press , 2021, Pages 271-281.
- ValterJacinto,2015 .http://www.prota4u.org/protav8.asp?h=M4&p=Rosmarinus+officinalis+L. -(http://paprikaet,chocolat.wordpress.com
- Vehling. J-D . (2020). The Project Gutenberg eBook of Apicius : Cookery and Dining in Imperial Rome. A Bibliography, Critical Review and Translation of the Ancient Book known as Apicius de re Coquinaria, https://www.gutenberg. org/files/29728/29728-h/29728-h.htm, accessed 16 November 2020.
- Voyage 3D au coeur du cheveu web site – URL : www.hair-science.com - Mars 2012.

- Voyage 3D on the website - URL: www.hair-science.com available at: http://id.erudit - Mars 2012.
- WHO. (2006) monographs on selected medicinal plants. World Health Organization, Geneva. http://apps.who.int/medicinedocs/en/d/Js2200e/.Google Schola
- Wolfram LJ. Human hair: a unique physicochemical composite. J Am Acad Dermatol, 2003, 48(6 Suppl):S106-S114.
- WOLLINGER. A; PERRIN. E; CHAHBOUN. J; JEANNOT. V; TOURAUD. D, KUNZ. W., 2016. Antioxidant activity of hydro distillation water residues from Rosmarinus officinalis L. leaves determined by DPPH assays. Journal of ComptesRendusChimie, 1 (1), 1-12.
- Yaacoub R et Tlidjane I,2018 . Caractérisation physico - chimiques et analyses biologiques de l'huile essentielle des grains de Cuminum cyminum L et de Foeniculum vulgare Mill extraite par hydrodistillation et CO_2 supercritique : Etude comparative .(en ligne) .Mémoire de Master: Genie Chimique,Oum El Bouachi .Universite Larbi Ben M'hidi -48p Disponible sur http://bib.univ-oeb.dz:8080/jspui/handle/.
- Yesil-Celiktas O., Girgin G., Orhan H., Wichers H-J., Bedir E. and Vardar-Sukan F. (2007b). Screening of free radical scavenging capacity and antioxydant activities of Rosmarinus Officinalis extract with Focus on location and harvesting times. European food research and technology 224: 443-51
- Žuvela, Petar et al. 2019. “Column Characterization and Selection Systems in Reversed-Phase High-Performance Liquid Chromatography.” Chemical reviews 119(6): 3674–3729

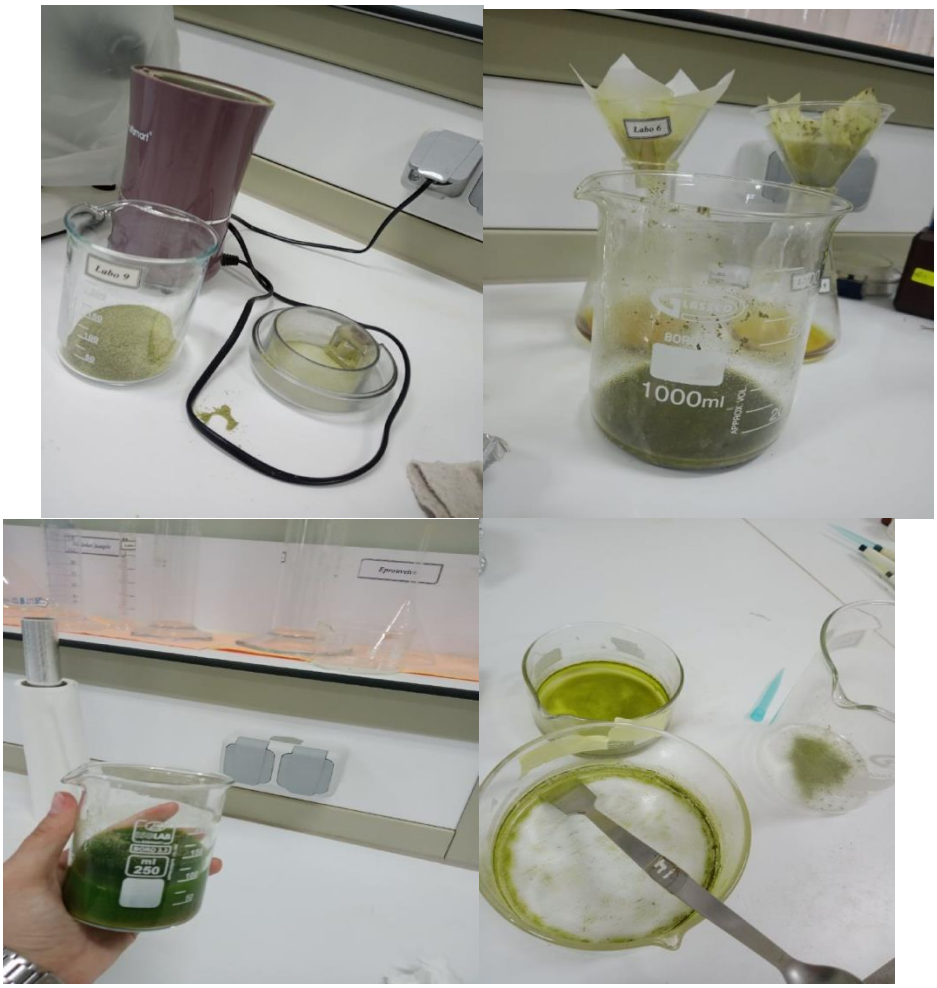
Appendix

Appendix (01) : the plants studied

Jabal Zbarbar, Douar Al-Gharantah Bouira

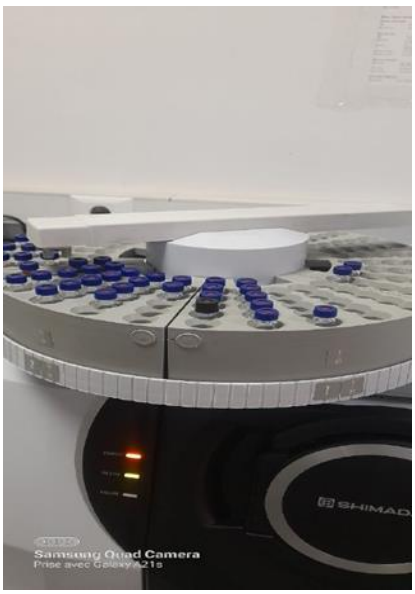
Rosemary plant

Appendix (02) : Extraction of extract

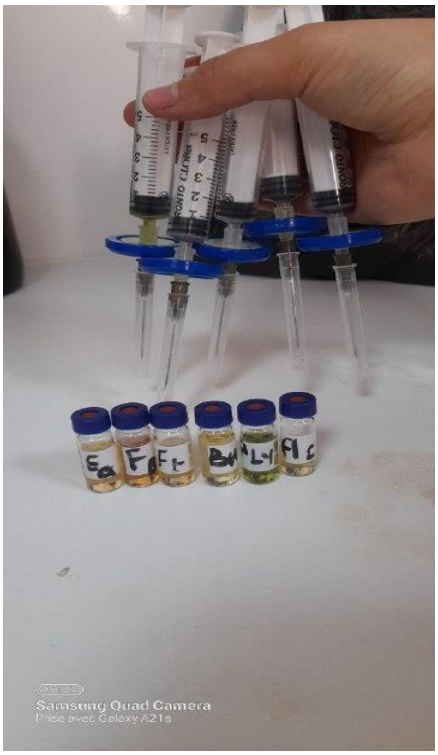


Appendix (03) :extraction of essentielle oil of rosmarinus officinalis by clivanger

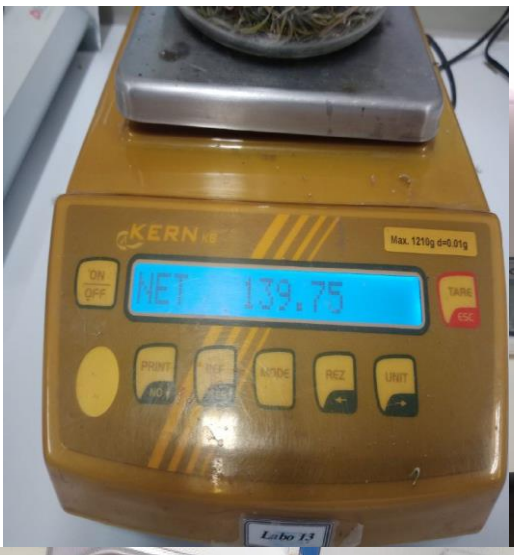
Appendix (04) : GC/MS Apparatus



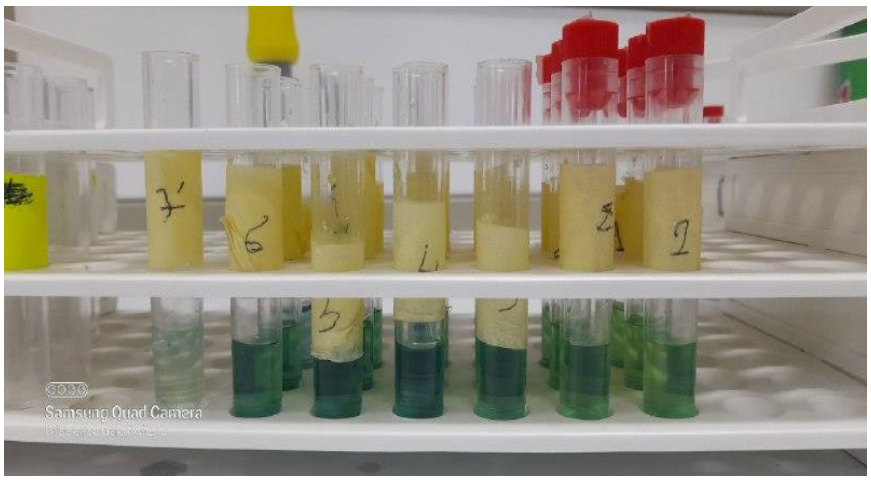
Appendix (05) : HPLC Apparatus



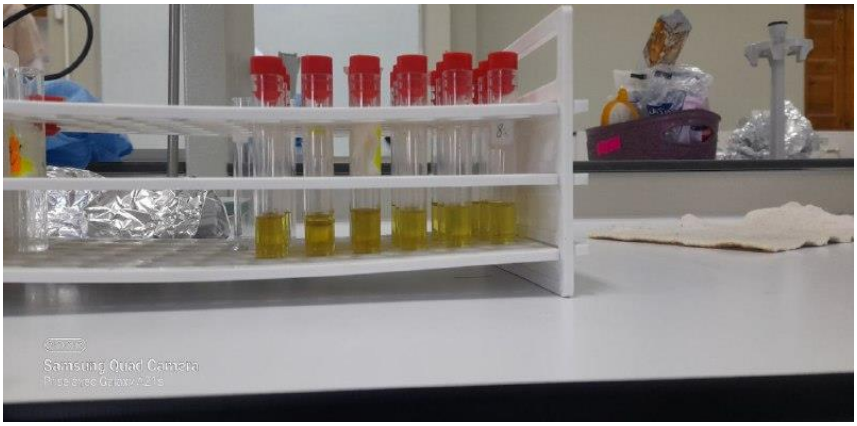
Appendix (06) : Apparatus used



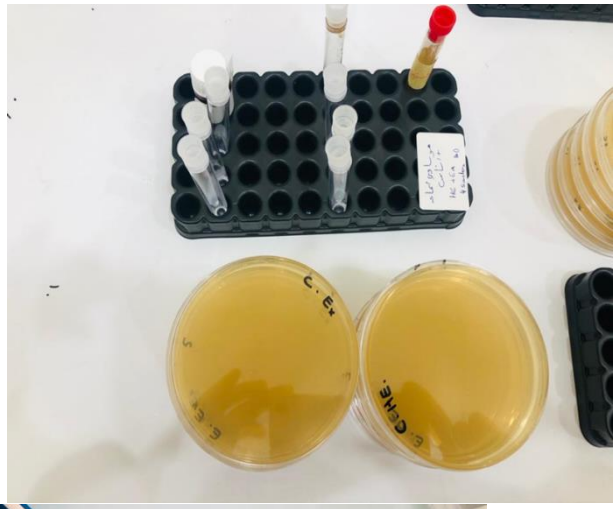
Appendix (07) : Teste FRAP



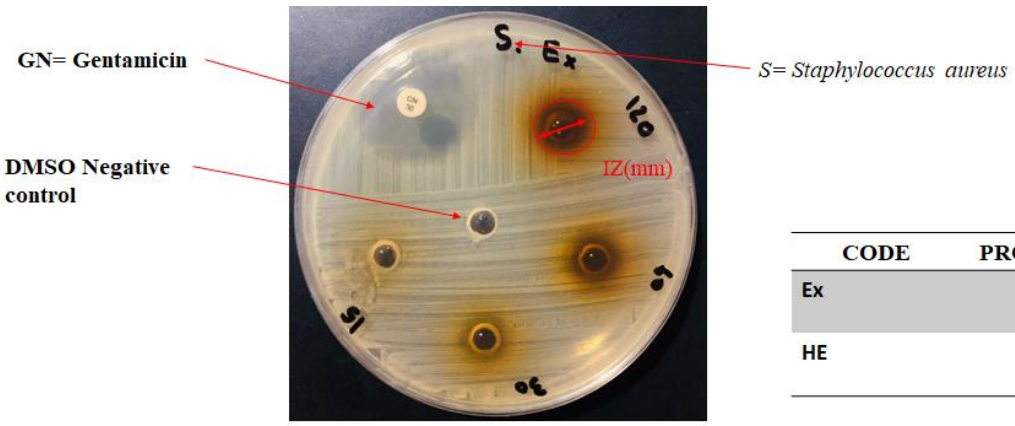
Appendix (08) : Test DPPH



Appendix (09) : Antimicrobial Activity



Appendix (10) : Exemple Antibacterial Tests



CODE	PRODUCTS
Ex	المستخلص
HE	الزيت الطيار

Figure : Antibacterial essay by the wells diffusion method for samples on agar plate

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