UNIVERSITE YAHIA FARES DE MEDEA

FACULTE DES SCIENCES

DEPARTEMENT DES SCIENCES DE LA MATIERE

Mémoire

Présenté pour obtenir le diplôme de **Master** en chimie

Spécialité : Chimie Pharmaceutique

Par :

Benadda Maroua

Thème :

Formulation of emulsion based on natural product

Dr Boucherit Nabila	MCA	President
Dr Mimi Nassiba	MCB	Examiner
Dr Arbia Wassila	MCA	Thesis supervisor

Année universitaire 2023/2024

Thanks

Firstly, we want to thank Allah who gave us the patience and support to achieve our goal.

Words couldn't help us expressing our deep appreciation to Dr.ARBIA WASSILA , Doctor at YAHIA FARES UNIVERSITY OF MEDEA , for her suggesting the research project and her patience, faithful advice and unlimited efforts in this research. Her guidance, recommendations, and unwavering support during our work.

We also would to express our gratitude to the jury members : Doctor MIMI.N and Doctor BOUCHERIT.N for accepting to judge our work, which is an honor for us.

We express our gratitude to the personnel of the University of Yahia Fares of MEDEA, particularly the director of the technological hall and the members of the chemical laboratories (***Mrs. Soumia*** and ***Mrs. Khaoula*** and ***Mrs. Safia*** and ***Mrs. Fouzia***).

In conclusion, we would like to express our deep gratitude to all the employers and administrators of our university.

DEDICATION

To my myself, thank you for your resilience, dedication, and hard work. Your perseverance and belief in your dreams have brought you to this moment. Thank you for the late nights, and the unwavering commitment to your goals.

To my Mom source of joy and happiness, Thank you for being my constant pillars of strength and sources of inspiration. Your unwavering support, love, and encouragement have been the driving force behind all my endeavors. words can not express my gratitude and appreciation for your dedication and sacrifices, you are always by my side to support me.

To my tresor and my spiritual support , to my one and only who always I work hard , and seeing him in all faces to my DAD (رحمة الله عليه)

To my bond in the world after the absence of the first bond, to whom I had the uninclined support , to my uncles ISMAIL and LAKHDER .

To my beloved brother ABDERRAHMANE , I appreciate your unwavering support

To my dear sisters, I thank you for your continued support. I'm lucky to have you by my side Particularly YAMINA , RAFIKA and SELMA

To all my dearest friends without exception : RANIA , MANAR , CHAHINEZ , NAZIHA , SABRA , MARWA and MAROUA .

To the women that made me a chemistry lover and believe in me since I was a little girl TATA ANISSA.

To my fiancé Hacene and all his family

To all those who participated directly or indirectly in my success.

To you dear reader.

MAROUA

ملخص

الهدف الرئيسي من هذا العمل هو تحضير مستحلب طبيعي وكريم علاجي باستخدام هذا المستحلب ومستخلص نبات التيوريكوم بوليوم ل. كشف الفحص الكيميائي النباتي عن وجود التانينات والكينونات وأنه غير سام بتركيز 800 ملجم/كجم. وأظهر فحص البوليفينول أن المستخلص الإيثانولي لنبات التيوريكوم بوليوم ل يحتوي على 83.33 ملجم من EAG/غرام وأظهر قياس النشاط المضاد للأكسدة أن نسبة IC50 % كانت 2.56 ميكروغرام/مل. أظهرت النتائج التي تم الحصول عليها أنه من بين التركيبات التي تم اختبارها، كانت التركيبات F1 و F5 هي الأكثر ثباتًا باستخدام المستحلب المحضر، والذي يتكون من زيتون البوتاسيوم وشمع الاستحلاب وكحول السيتيل وليسيثين الصويا. يسمح هذا المستحلب بالاستحلاب الساخن بطريقة الوعاء الواحد أظهر توصيف كريم الشفاء المحضّر أنه مستحلب زيت في الماء مع درجة حموضة 6 (بعد التعديل) وموصلية 860 ميكروسيمين/سم. تم تحضير الفحم المنشط باستخدام الكتلة الحيوية للتيوريكوم بوليوم ل، الذي تم استعادته بعد الاستخلاص، واستخدم لتحضير صابون لين من الفحم المنشط.

الكلمات المفتاحية: مستحلب طبيعي، استحلاب طبيعي، استحلاب ساخن، مستحلب، جزيء نشط بيولوجياً، مستخلص نباتي، التئام الجروح , صابون لين .

Résumé

L'objectif principal de ce travail est de préparer un émulsifiants naturel et la préparation d'une crème cicatrisante en utilisant cet émulsifiant et l'extrait végétal de la plante *Teuricum polium* L. Le screening phytochimique a permis de mettre en évidence la présence de tanins et les quinones et qu'il ne présente aucune toxicité à une concentration de 800mg/kg. Le dosage des polyphénols a montré que l'extrait éthanolique de *Teuricum polium* L contient 83.33mg EAG/g. La mesure de l'activité anti-oxydante a montré qu'IC50% est de 2.56 µg/ml. Les résultats obtenus ont montré que parmi les formulations testées : F1 et F5 étaient les plus stables en utilisant l'émulsifiant préparé qui est constitué de l'olivate de potassium, la cire émulsifiante, l'alcool cétylique et lécithine de soja. Cet émulsifiant permet une émulsification à chaud par la méthode one- pot. La caractérisation de la crème cicatrisante préparée a montré que c'est une émulsion huile-dans-eau de pH 6 (après ajustement), de conductivité 860µs/cm. Le charbon actif est préparé en utilisant la biomasse de *Teuricum polium* L récupérée après l'extraction, a été utilisé pour la préparation d'un savon mou au charbon actif.

Mots-clés : émulsifiant naturel, émulsification à chaud, émulsion, molécule bioactive, extrait végétal, cicatrisation , savon mou.

Abstract

The main aim of this work is to prepare a natural emulsifier and a healing cream using this emulsifier and the plant extract of Teuricum polium L. Phytochemical screening revealed the presence of tannins and quinones, and that it is non-toxic at a concentration of 800mg/kg. Polyphenol assays showed that the ethanolic extract of Teuricum polium L contained 83.33mg EAG/g. Measurement of antioxidant activity showed that IC50% was 2.56 µg/ml. The results obtained showed that among the formulations tested: F1 and F5 were the most stable using the prepared emulsifier which consists of potassium olivate, emulsifying wax, cetyl alcohol and soy lecithin. This emulsifier enables hot emulsification by the one-pot method. Characterization of the prepared healing cream showed it to be an oil-in-water emulsion of pH 6 (after adjustment), conductivity 860µsiemens/cm. Activated charcoal is prepared using the biomass of Teuricum polium L, recovered after extraction, was used for the preparation of an activated charcoal soft soap.

Keywords: natural emulsifier, hot emulsification, emulsion, bioactive molecule, plant extract, wound healing , soft soap .

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List of abbreviation

CMC : critical micelle concentration

O/W : oil in water

W/O : water in oil

General introduction

Emulsions are widely used and present in many industries these days, including the pharmaceutical industry, the food industry (milk, butter, mayonnaise, etc.), the cosmetic and chemical industries and the painting industry . The pharmaceutical industry has several uses, including parenteral emulsions, topical ointments, and oral ointments, among others.

The study of emulsions is essential in the industrial field to stable products with the properties expected by the consumer. In the current context, consumers desire to buy increasingly natural products the need to research and formulate emulsions without chemical ingredients. The formulation of emulsions based on natural products involves the combination of immiscible liquids, typically oil and water, with the help of emulsifiers and other additives. Emulsifiers are essential in cosmetic creams as they enable the combination of aqueous and oily phases, which are immiscible by nature. This allows for the creation of stable and luxurious products that can effectively deliver active ingredients to the skin.

When selecting an emulsifier for a cream, several factors must be considered, including the type of emulsion desired (oil-in-water or water-in-oil), processing conditions, rheology and texture, and compatibility with other ingredients. Natural emulsifiers can be used alone or in combination with other ingredients to achieve the desired properties in a product.

Natural plant extracts can be used to create emulsions with antimicrobial and antioxidant properties, offering sustainable alternatives to synthetic chemical.

The aim of our work is to formulate and develop emulsions using a natural emulsifier based on plant and animal matter, and to characterize them in order to assess the optimum conditions for obtaining a stable cream with healing and anti-bruising effects.

This dissertation is divided into three chapters:

The first chapter corresponds to the bibliographical study, in which we present general information on emulsions, their description, their characterization, their preparation method, wound healing and medicinal plants.

The second chapter presents the equipment and products used in this work, as well as the methods of preparation and analysis of the emulsions and creams prepared.

The third chapter presents the experimental results, interpretation and discussion.

My thesis ends with a conclusion and some perspectives

Chapter I

bibliographic part

Today, emulsions are systems that are of great interest in our everyday lives. They are widely used in many industrial sectors, such as agri-food (sauces, dairy products, etc.), cosmetics (moisturizing creams, toothpaste, etc.), oil engineering, and public works (to facilitate the flow of inherently very viscous substances).

Emulsions are distinguished by their thermodynamic instability. The analysis of their stability is of paramount importance. During this section of our study, we will expose the bibliographic research that brings together the general concepts of emulsions, their main characteristics, the various mechanisms of instability, emulsifiers, formulation, and their main regulations.

I. Emuslion

I. 1. Definition

An emulsion is a system consisting of at least two non-miscible liquids, including one is scattered in the other, in a more or less stable form (Figure I.1) (Doumeix, 2011). Is a dispersion of a non-miscible liquid into small droplets called phase dispersed, internal or discontinuous in another non-miscible liquid called continuous phase, dispersion medium or external phase (Chadli, 2019).

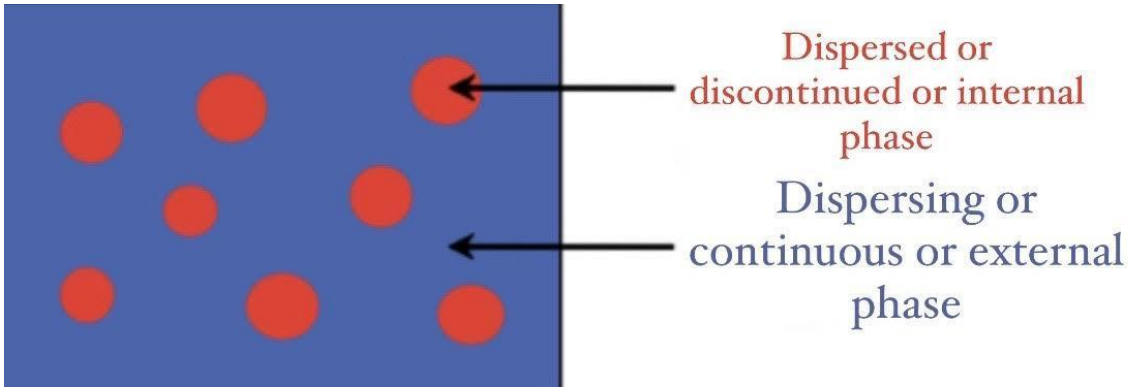


Figure I. 1. Emulsion : dispersed and dispersing phases (Doumeix, 2011).

In order for the emulsion to be durable, it is necessary to use an emulsifying agent. Its role is to stabilize the dispersed system by inhibiting degradation phenomena (Rahmouni, 2016) (Table I.1) (Doumeix, 2011).

Table. I. 1. Place of emulsions within dispersed systems (Doumeix, 2011).

Physical state of the dispersed phase	Physical state of the dispersing phase	Result of the dispersion
Liquid	liquid	Emulsion
Solid	liquid	Suspension
Liquid	Gas	Aerosol
Solid	Gas	
Gas	Liquid	foam

I. 2. Classification of emulsions

I. 2. 1. According to the volume fraction

Emulsions are also classified according to the dispersed phase volume fraction (Φ). In particular, emulsions are considered diluted if the volume fraction (Φ) is less than 5% and concentrated when it is greater than or equal to 74%; this value corresponds to the volumetric fraction of the compact stack of non-deformable spheres of the same size. These emulsions can reach values of 99%, which is why they are called highly concentrated emulsions. In addition, the droplets in the continuous phase are not homogeneous (Benmeziane, 2013).

I. 2. 2. Depending on the type of emulsion

- **Simple emulsion :** A monophasic liquid dispersed in another liquid (table I.2) (Rahmouni, 2016).

Table I. 2. The two types of simple emulsion (Rahmouni, .2016**).**

Dispersing phase	Dispersed phase	Emulsions direction
Oil n in Water emulsion (Aqueous Emulsions or External Water Emulsifiers)	Hydrophile	Lipophile
Water in Oil emulsion (Oil type emulsion or External Oil Emulsions).	Lipophile	Hydrophile

There are two types of simple emulsion (Fig. I. 2)

- Simple emulsion: These are water drops dispersed in the oil (W/O)
- Reverse emulsion: These are oil droplets dispersed in water (O/W)

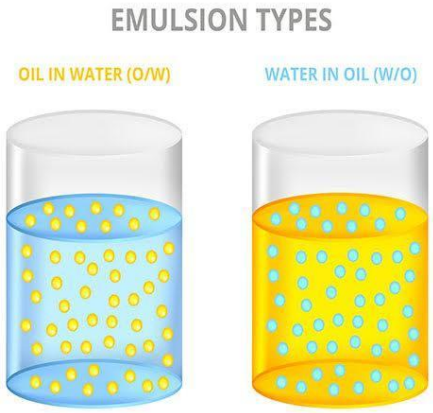


Figure I. 2. The two types of single emulsion (Rahmouni, 2016).

- **<u>Multiple emulsions</u>:** emulsion emulsions or emulsional dispersion (Figure I.3) (Rahmouni, 2016).

There are two types of simple emulsion (Fig. 1. 2)

W/O/W emulsion: the dispersion of O/W emulsions in the aqueous phase. O/W/O emulsion: the dispersion of a W/O emulsion in an oil phase (Doumeix, 2011).

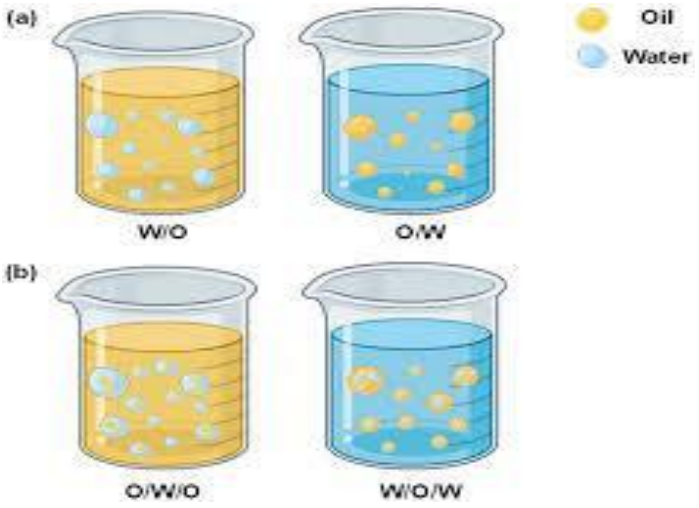


Figure I. 3 . The two type of multiple emulsions (https://www.researchgate.net/figure/Emulsion-types-a-Simple-emulsion-and-b-multiple-emulsion_fig)

I. 2. 3. Depending on the size of the droplets

Emulsions are classified according to the size of the dispersed phase droplets into three main types (Table I.3) (Rahmouni, 2016)

Table I. 3. Classification of emulsions by drop size (Rahmouni, 2016).

Type	Size of droplets	Features
Macro emulsion or emulsion	1 to 10 µm	An immiscible liquid dispersed in another liquid in the form of drops forms a rough emulsion with a milky white appearance.
Mini emulsion or nano emulsion	0.1 to 1 µm	White emulsion whose diameter varies between 0.5 and 1 µm. Fat emulsion has a diameter between 0.1 and 0.5 µm.
Micro emulsion	≤0.1 µm	The dispersion has stable, transparent to semi-transparent thermodynamics.

I. 3. Description of the emulsion

I. 3. 1. Aspect

The appearance of emulsions depends on three parameters:

- The size of the droplets in the dispersed phase
- The concentration of the emulsion.
- The ratio of refraction index between the dispersing phase and the dispersed phase.

The appearance of emulsions depends on the ratio between the transmitted light and the diffused light. The bigger the droplets, the larger the diffusion, and the more opalescent and white the emulsion will appear. In the case of microemulsions, the system is translucent (Table I. 4) (Stauffer, 2014).

Table. I. 4. Type of aspect of emulsion depending on the size of drops

Size of drops	Aspect of emulsion
> 100 µm	Visible drops
10-100 µm	Milky white
0.1-10 µm	opalescent
< 0.1 µm	translucide

I. 3. 2. Concentration

The term emulsion concentration actually refers to the concentration of the dispersed phase. This concentration is measured by the volume fraction of the diffused phase, or retention rate.

This parameter is determined by the stability of the emulsion, its manufacture, and its macroscopic properties. In fact, it is a presentation of the interactions observed between droplets. Three types of emulsions are defined by this parameter (Table I.5) (Belhadj et al., 2014).

Table. I. 5. Type of emulsion by concentration (Belhadj and al, 2014).

	Type of emulsion
<0.2	Diluted emulsion
0.74< Φ <0.3	Concentrated emulsion
> 0.74	Very concentrated emulsion

I. 3. 3. Granulometry

Granulometry defines the size of the droplets in the dispersed phase. A size distribution and average diameter are defined (Belhadj et al., 2014). There are two types of emulsions: monodispersed and polydispersed. A single-dispersed emulsion contains a single population of droplets of the same size, whereas polydisperse emulsions contain several populations of different sizes (Cuallet et al., 2017). One of the important concepts for defining the granulometry of the emulsion is the average diameter. It is most sensitive to the presence of large particles. The monitoring of this parameter helps to highlight the phenomenon of flocculation or cremation. So it allows us to check the stability of the emulsion (Stauffer, 2014).

I. 3. 4. Interfacial area

Interface area (A) is the particle area calculated from the jump diameter (Belhadj, 2014). This size determines the amount of emulsifier and the energy to be supplied for emulsification. The higher the interface area, the more efficient the process has been (Doumeix, 2011).

I. 3. 5. Rheology

Rheology studies the flow of materials subjected to mechanical stress. The two extreme behaviors are those of a purely elastic solid that does not flow and those of an ideal fluid called a newtonian. Emulsions have an intermediate behavior; they present a resistance to the flow, so they are viscous and can undergo reversible deformations; therefore, they are elastic; they are called viscoelastic.

The viscosity of an emulsion determines its conditioning, ease of use, and some of its sensory properties. It is therefore a key parameter, determined by the composition and structure of the emulsion (Doumeix, 2011). The rheology of emulsions is a very important feature that generally depends on the following properties :

-The volume fraction of the dispersed phase,

-The nature and concentration of the emulsifying agent,

-Average particle size and granulometric distribution,

-The viscosity of the continuous phase and, to a lesser degree, that of the dispersed phase -Water/Oil Interface Voltage (Ferarsa et al., 2011).

I. 4. Application of emulsion

I. 4. 1. Emulsions in the agri-food sector

Direct emulsions are used for the encapsulation of lipophilic compounds. Similarly, multiple emulsions also have many potential applications to encapsulate and protect hydrophilic compounds, such as volatile fragrances, to improve the sensory capacity of certain foods, as well as to mask the unpleasant taste of certain molecules. They can also be used for the manufacture of fat-lighted products, with the internal water reducing the amount of oil used while preserving the texture (Protat, 2016).

I. 4. 2. Emulsions in the cosmetics field

The emulsion form has several advantages for a cosmetic product, mainly:

- Possibility of simultaneously applying liposoluble and water-soluble ingredients.
- Easy to use.
- Pleasant and effective skin contact (ease of spreading) (Doumeix, 2011).

I. 4. 3. Emulsions in the pharmaceuticals field

This is the area that we are most interested in in this study; it is to increase the absorption of oils through the intestinal barrier, skin, and tissues. The different pathways of administration are:

- The oral route allows to improve the palability for the oils in the oral way,
- The intramuscular pathway ensures prolonged release of the administered product,
- The rectal pathway: the chronic treatment of constipation,
- Local route,
- O/W emulsion is less oily, easier to wash, and has more cosmetically acceptable characteristics
- W/O emulsion, moisturizing effect, used for softening dry skin as well as Prevention of skin cracks (Stauffer, 2014).

I. 4. 4. Other fields of application of emulsions

In the oil field, stimulable emulsions are extensively studied for oil recovery. In fact, the high-pressure injection of a water solution containing an emulsifier allows the oil stuck in the porosities of the rock to be recovered in the form of a direct emulsion. The use of stimulable emulsifiers then allows for the breaking of this emulsion in order to recover the oil. In the building and road coating sectors, emulsions are used to more easily handle highly viscous fluids such as bitumen. In agriculture, emulsions are used to formulate active substances such as pesticides or herbicides (Protat, 2016).

I. 5. Emulsion stability/instability phenomenon

I. 5. 1. Stability of an emulsion

Emulsions are thermodynamically unstable due to their decomposition, resulting from a decrease in free energy (equality of chemical potential between two phases). Its stability has several aspects: physics, chemistry, and microbiology.

I. 5. 1. 1.Chemical stability : implies that the coexistence of the ingredients in the formulation does not interact with each other to affect the quality of the emulsion (Amrouche, 2019).

I. 5.1.2.Microbiological stability: The emulsion must not be a medium for the cultivation of yeasts, molds, and bacterial germs.

I. 5. 1.3. Physical stability: although the emulsion may be physically stable, it does not show a phase separation that represents different types of physical instability (Chadli, 2019).

I. 5. 2. Physical instability

I. 5. 2. 1. Cremation and sedimentation phenomenon

This mechanism is the result of the density difference between the dispersed phase and the continuous phase. Cremation is spoken of when the dispersed phase rises and sedimentation when it falls. It is a reversible phenomenon (Adali et al., 2015) (Fig.I. 4).

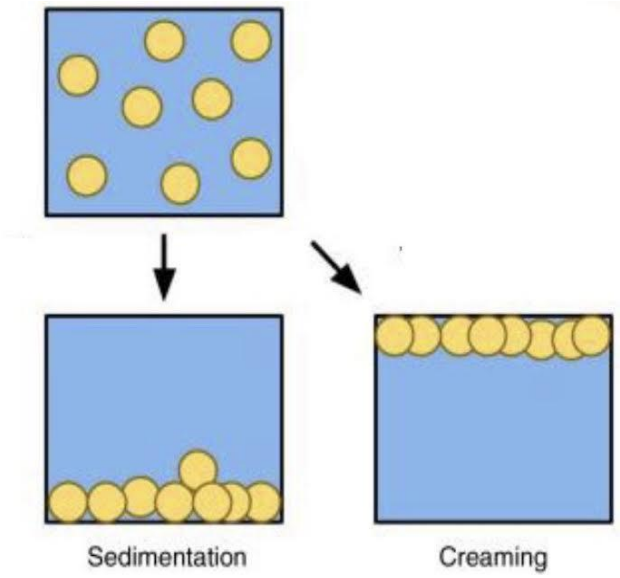


Figure I. 4. Descriptive scheme of cremation and sedimentation phenomena (Cuallet et al., 2017**)**

The creaming phenomenon can be eliminated by increasing the viscosity and decreasing the difference in the volume mass and average radius of the droplets (Chadli, 2019).

I. 5. 2. 2. Flocculation phenomenon

This phenomenon occurs due to the aggregation of droplets resulting from attractive interactions, as shown in Figure I.5 (Cuallet et al., 2017).

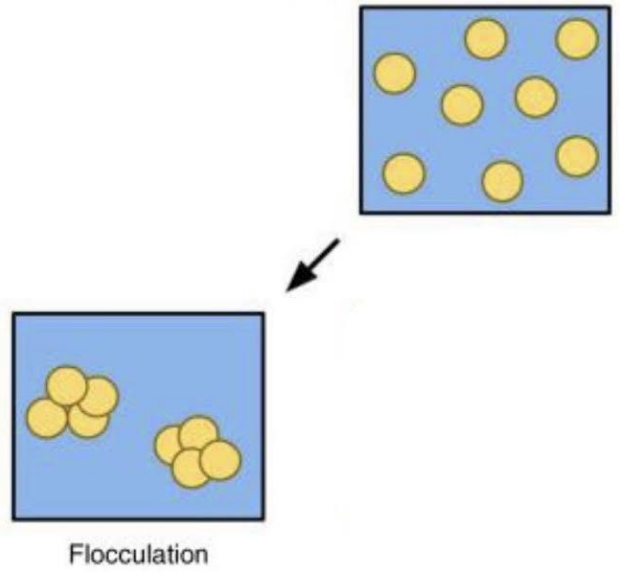


Figure I. 5. Descriptive scheme of a flocculating phenomenon in an emulsion (Cuallet et al., 2017)

Flocculation occurs when the repulsive forces are insufficient to keep the drops away at distances or when Van Der Waal's attraction forces are dominant. The flocculation can be "strong" or "weak", depending on the magnitude of the attracting energy (Chadli, 2019).

I. 5. 2. 3. Coalescence phenomenon

Coalescence is a form of instability in which the flocculated droplets lose their interfacial film and merge irreversibly, forming larger drops. The behavior of two droplets that approach each other depends on the interaction of hydrodynamic forces and surface forces. The hydrodynamic forces are responsible for the flow of liquid between droplets and for the deformation of these. The surface forces can either oppose these phenomena when they are strong enough or favor them when they are weaker (Kara and al, 2017) (Fig. I. 6) (Dupont, 2017).

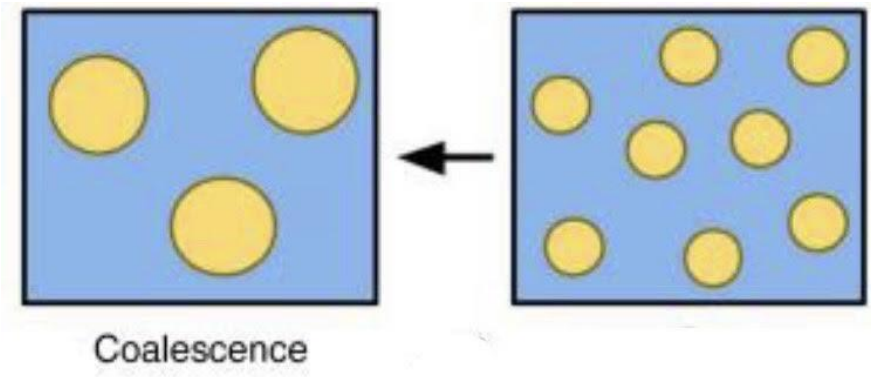


Figure I. 6. Descriptive pattern of the coalescence phenomenon in an emulsion (Dupont, 2017)

I. 5. 2. 4. Ostwald murder or molecular diffusion

We speak here of murdering because, during this phenomenon, the smallest droplets diffuse into the larger ones through the continuous phase (Fig. I. 7) (Dupont, 2017).

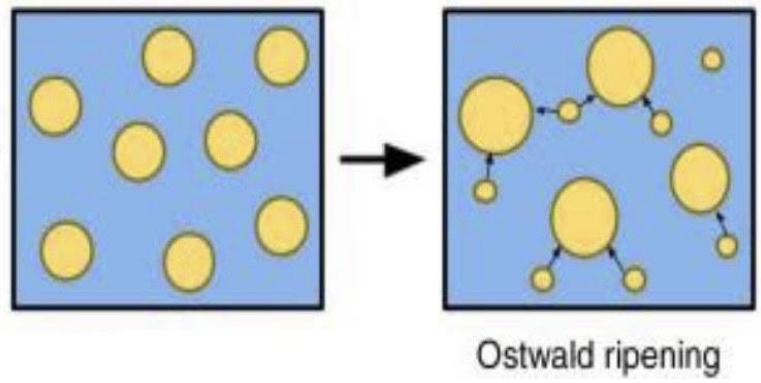


Figure I.7. Descriptive scheme of Ostwald melting phenomenon in an emulsion (Dupont, 2017)

This phenomenon is due to the pressure difference inside the drops and, more specifically, to the Laplace pressure exerted on the drop interface. It can be mastered through:
- An homogenization of the size of the droplets,
- It can be delayed or interrupted by the addition of components that are poor or insoluble in the continuous phase (Dupont, 2017).

I. 5. 2. 5. Phase inversion phenomenon

Phase inversion is the transformation of the H/E emulsion to the E/H emulsions, or vice versa. The phase inversion phenomenon (Fig. I. 8), can modify the physico-chemical properties of the emulsion. It can be regulated by controlling the emulsion concentration, temperature, type, and concentration of the emulsifier (Chadli, 2019).

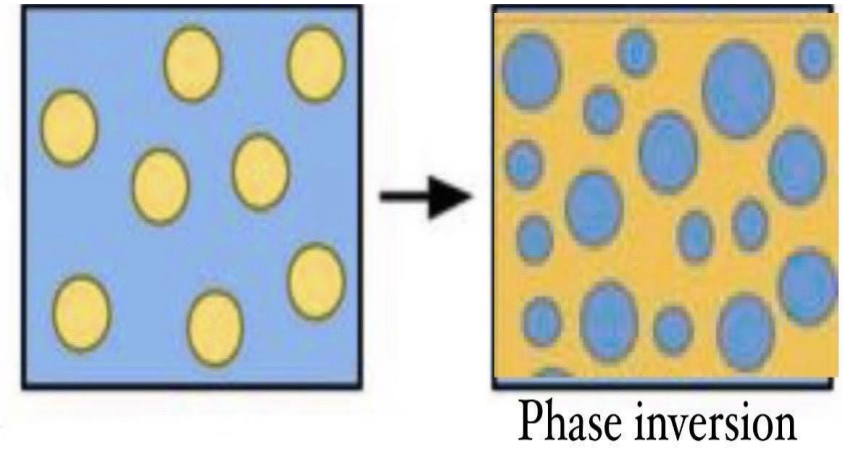


Figure I. 8. Descriptive scheme of phase reversal phenomenon in an emulsion (Dupont, 2017).

I. 6. Composition of the emulsion

I. 6. 1. Oil phases and aqueous phases

- **Oil phase**

Also called the fat phase, lipophile phase, or organic phase, it is usually made up of a mixture of ingredients of different origins (Adali et al., 2015). It may consist of oils, fats, and/or waxes, which, at room temperature, are found in liquid, semi-solid, and solid forms, respectively. Synthetic substances may be used (Table I.6).

Table 6. Examples of oil phase ingredients (Dupasquier et al., 2015)

Origin	Fatty	Wax	Oils
Animal	Bee wax, white whale	Lanoline	Whale oil, requicle liver
Vegetable	Carnauba wax	Karite Butter Cocoa Butter	peanut, olive, almond, soybean oil...
Vegetable	Paraffin	Vaseline	Paraffin Vaseline
Synthetic	Fatty Esters	Fatty Esters	Esters and fatty alcohols in silicone oils

- Aqueous phase

The so-called hydrophilic phase contains water and various water-soluble components (Adali et al., 2015). Depending on the field of application (food, cosmetic, or pharmaceutical) and the type of emulsion, different substances can be added in the lipophilic or hydrophilic phase to give the product various properties. These different ingredients distribute this between the two phases according to their solubility.

I. 7. Molecules stabilizing emulsions

I. 7. 1. Stabilizing effects

Stabilizing agents play an essential role in the formation and preservation of emulsions. We present here some notions of stabilizers that are useful to know to properly approach emulsification **:**

- Emulsifying agent: substances added to the emulsion, consisting of surfactants promoting the formation of intimate mixtures between non-miscible liquids (e.g., propylene glycol myristate).

-**Absorbent agent:** substances added to the emulsion to absorb water-soluble and/or liposoluble substances, which would be dissolved or finely dispersed (e.g., magnesium aluminum silicate).

-Viscosity control agent: substances added to products to increase or decrease the viscosity of the finished product (e.g., carbomer).

-**Binding substances:** substances added to enhance product cohesion (e.g., methyl cellulose).

-appeasing substances: substances added to the emulsion that are transparent or translucent in order to make it more resistant to the penetration of visible light and near-light radiation (e.g., magnesium aluminum silicate, calcium carbonate).

-Antistatic agent: substances added to the emulsion to reduce static electricity by neutralizing the electrical charge present on a given surface (example: hydroxypropyl gaur) (Belhadj et al., 2014).

I. 7. 2. Emulsifiers

I. 7. 2. 1.Definition

Conventional emulsions are thermodynamically unstable systems that split more or less quickly into two phases. We're talking about out-of-balance systems. Due to this instability, industrial emulsions still contain emulsifiers, forming an interfacial film, or thin film, around dispersed-phase. These are most often small amphiphilic molecules called surfactive, surfactant , or surface agents. (Doumeix, 2011).

I. 7. 2. 2.ductile substances

The surfactants are amphiphilic organic molecules, with two distinct parts : a hydrophile polar head, which has a high affinity for water molecules, and a hydrophobic (lipophilic) apolar tail (Fig. I.10) (Doumeix, 2011), which water molecules tend to run away from. The hydrophilic head is usually composed of an ion or cluster that has a dipolar moment and the hydrophobic tail of one or more aliphatic chains (Adali et al., 2015).

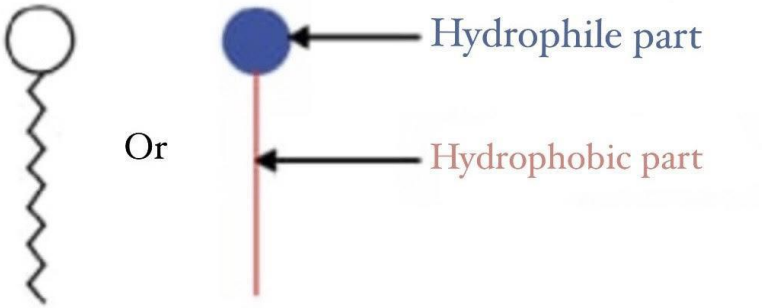


Figure I.10. Classical schematization of a surfactant (Doumeix, 2011)

Note : Not all surfactants (TAs) are used as emulsifiers, e.g. amphoter TAs.

I. 7. 2. 2.1. Chemical classification of surfactants

-Ionic surfactants

The charge of ionizable clusters depends on the pH. Ionic surfactants are therefore only usable under certain conditions, which makes their use less common than non-ionic surfaktants (Stauffer, 2014).

-Anionic and cationic surfactants:

are incompatible (if mixed, they form an insoluble complex). Active only at a certain pH (alkaline Alin for anionic, acid for cationic) (Doumeix, 2011).

-Non-ionic surfactants

Non-ionic surfactants, whose shape is pH-independent, are the most widely used. They are generally classified according to the nature of the bond that connects the hydrophilic pole to the hydrophobic pole. (Belhadj et al., 2014). Therefore, they are excellent candidates for complex formulations. Non-ionic surfactants are emulsifying, solubilizing, and moisturizing (Benmeziane, 2013). One of the most common patterns among non-ionic surfactants .

I. 7. 2. 2.2. Physico-chemical classification of surfactants

Surface agents can also be classified according to their physicochemical properties. These properties are expressed through an adimensional number: the HLB (hydrophilic lipophilic balance) (Stauffer, 2014). It participate in the choice of the surfactant according to the direction of the chosen emulsion and to estimate the hydrophilic/hydrophobic ratio. It was developed by Griffin in 1949 (Chadli, 2019).

The roles that can be played by the surfactants according to their HLB are determined on a scale of 1 to 20. When the HLB value is high (≥8), the hydrophilic fraction is predominant, in which case the surfactant acts as an O/W emulsifier. However, if it is weak (≤8), the molecule is more lipophile than hydrophile, and its role in this case is emulsifying W/O (Chadli, 2019) (table I.7).

Table I.7. Role of surfactants according to their HLB (Belhadj et al., 2014)

	Role
3-6	W/O Emulsifier
7-9	Moisturizing
8-18	O/W Emulsifier
15-18	Solubilizer

- **Polyosides**

The majority of natural polyosides are hydrophilic. Emulsifying polyosides are obtained by transplanting hydrophilic polymers into hydrophobic collections . This is the case for some modified starches or cellulose. The interfacial activity of these remaining molecules low, they must be used at high concentrations to produce stable emulsions (Doumeix, 2011).

- **Liquid crystals**

It may be interesting to use liquid crystals to stabilize the emulsions. This stabilization is also entropic (steric), with liquid crystals forming at the interface and creating a barrier that significantly inhibits the coalescence phenomenon (Belhadj et al., 2014).

- **Solids finely divided**

Spraying solids, insoluble in both phases, can act as emulsifiers by positioning on the membrane involved in the coalescence. Sometimes we talk about interface raiders. Emulsions lacking and stabilized by solid particles are called Pickering emulsions. The substances used are generally of mineral origin, such as talc (Doumeix, 2011).

I. 7. 2. 3. Emulsifying role

The emulsifier can affect the stability of an emulsion in three ways**:** **1.** Either by decreasing the interfacial tension between the two liquids. This property is responsible for the phenomena of moisture, dispersion, detergent, and emulsification. **2.** Either by increasing the viscosity of the preparation, for example, in the case of rubber. **3.** Either by acting both on the interfacial tension and on the viscosity, this is what occurs when a non-ionic surface is placed in large excess; one part acts on the interface to lower the interfacial surface and the other increases the viscosity of the dispersing aquatic phase (Benmeziane, 2013).

I. 7. 3.4. Viscosity additives

Viscosity additives are molecules that stabilize emulsions by increasing continuous-phase viscosity (Doumeix, 2011). The most commonly used W/O additives are hydro-colloids, which stabilize the aquatic phase at low concentrations thanks to their thickening or gelizing properties. Most are carbohydrates (Arabic rubber, agar, and starch), but there are also proteins (gelatin) or synthetic molecules (carboxyvinylic polymers) that can perform this role. O/W additives are mostly synthetic or semi-synthetic (colloidal silices). They are less used than E/H additives because the oily phases have a higher viscosity than water, and it is often easier to change the composition of the fatty phase rather than add an additive viscosity (Belhadj et al., 2014).

I. 8. Formulation

Depending on the nature of the emulsion you want to obtain, manufacturing involves a series of choices, such as **:**

-The type of emulsion (W/O or O/W).

-The ingredients (the nature of the 2 phases, emulsifiers, additives, etc.).

-The process.

I. 8. 1. General rules of formulation

I. 8. 1. Selection of the oil phase

The selection of the oil phase ingredients is the first step; the hydrophilic phase is always aqueous. It depends on factors :

* Physico-chemical (property of the ingredients determining the properties of the emulsion: viscosity, solubility, melting point, etc.).

* Regulatory (ingredients permitted or prohibited in such a sector).

* Economic (cost of raw materials).

* Marketing.

Once the basic ingredients have been chosen, the formulation is to select the most effective surfactants, resulting in an optimal form of stability. The outcome of the formulator's work is the formula of the emulsion, which gives the complete composition (Doumeix, 2011).

I. 8. 1. 2. Choice of surfactants

The choice of surfactants is very important because they ensure the formation and stability of the emulsion over time. On the other hand, the use of a single surfactant does not always ensure optimal stability. One pair of surfactants, one hydrophilic (HLB $\geq$ 10), the other hydrophobic (HLB $\leq$ 10), is always more effective than a single surfactant; one of the two surfactants is sometimes called co-tensioactive.

The effectiveness of surfactants as emulsifiers is mainly due to their inhibitory action against flocculation and coalescence. When two surfactants are used, one ensures the stability of the interface by decreasing the interfacial voltage, while the other prevents flocculation by electrostatic and/or steric effects. However, many commercial emulsions contain only one surfactant. Therefore, the use of surfactant pairs is especially important for the stabilization of fine emulsions and indispensable for microemulsions (Doumeix, 2011).

I. 8. 2. Emulsification

Generally speaking, emulsification is broken down into two successive stages: first a dispersion-mixing stage, called pre-emulsion, which will lead to a simple suspension of the droplets from the dispersed phase to the continuous phase (drops of the order of 100 μm), then a so-called homogenization stage, whose purpose is to reduce the size of drops so as to give the emulsion the required properties and stabilization. (Pierat, 2010). The preparation of an emulsion requires precise work to reduce the phase into small droplets and disperse them throughout this phase. The addition of emulsifying agents not only reduces this work but also stabilizes the final.

I. 8. 2. 1. Emulsification by mechanical agitationϖ

Manufacturing steps: The different stages of the manufacture of an emulsion are given in Figure I.13.

- **Preparation of the aquatic and oil phases**

The purpose of this step is to condition the aquatic and oily phases before emulsification. The oily phase, often times a greasy textured paste or even solid, must be heated (between 70 and 90 °C) in order to reach a viscosity that makes it easy to handle. The emulsifiers are added during this step. The operation takes place in an agitated tank equipped with a propeller or a turbine, to which a mobile is added to ensure a good thermal transfer (ancre, par exemple). For the aquatic phase, a turbine or propeller can be used at temperatures ranging from 30 to 90 °C (Ouatas et Mansouri, 2020).

- **Mixing and dispersion**

The nature of the dispersion created depends not only on the formulation but also on the operating mode and the way the scattered phase is introduced into the continuous phase. This operation takes place in a tank equipped with radial movements whose role consists in the simple suspension of the drops, which leads to a relatively high granulometry (around 100 μm), and a depressor is used (Ouatas et Mansouri, 2020).

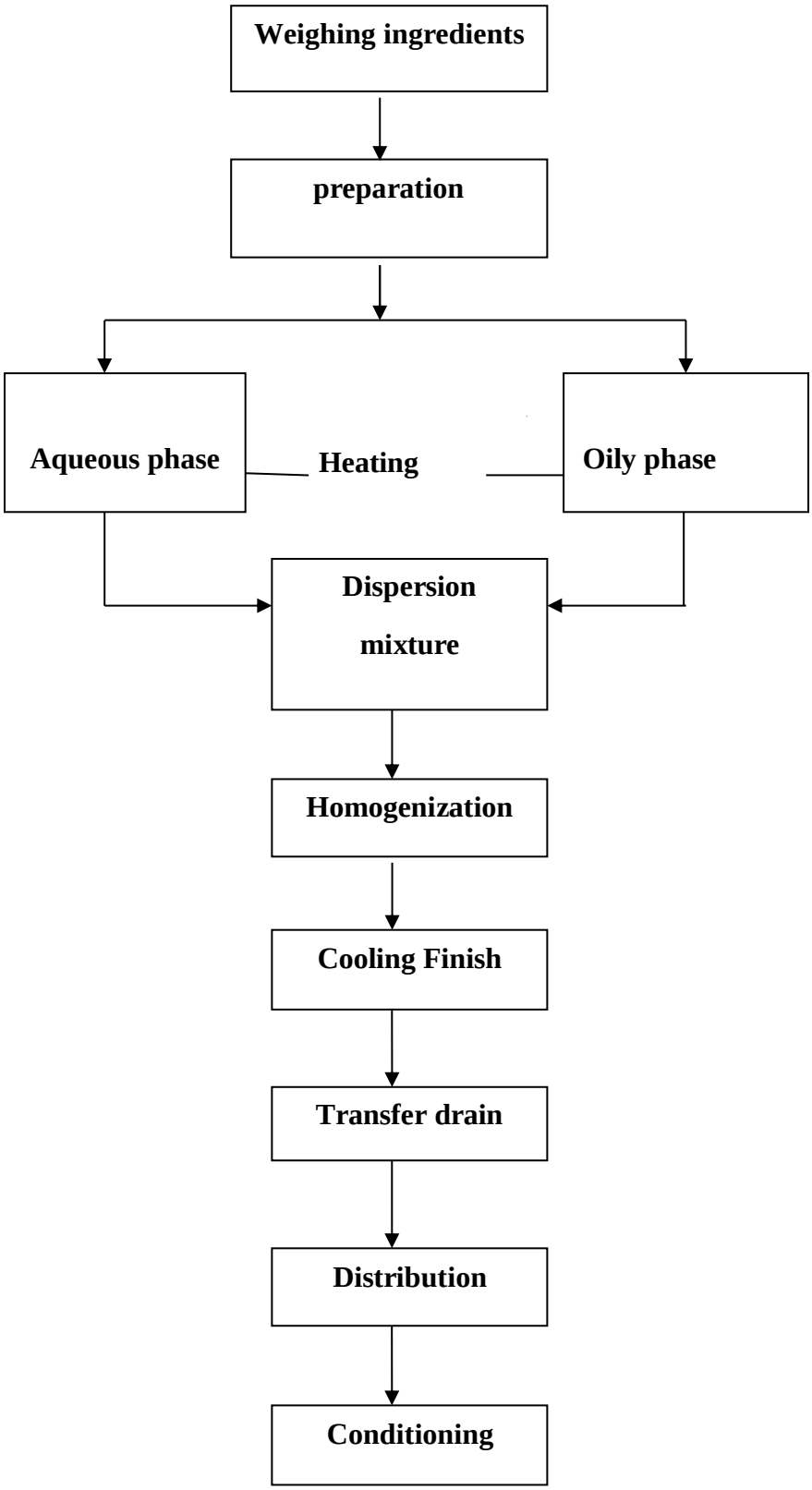


Figure. I. 13. Manufacture stages of an emulsion.

- **Homogenization**

This step is essential to obtaining a fine and stable emulsion. Maximum cutting is then sought by the use of a turbine, a rotor-stator system (e.g., a colloidal mill), and a high-pressure homogenizer. Cavitation phenomena can also be exploited (exemple: ultrasons).

- **Cooling and finishing**

The speed of the drop size implies strong cutting. The choice of the method and the operating parameters is made according to the size range to be achieved and the viscosity of the pre-mix (Joel, emulsions); therefore, additives can be incorporated in order to correct the viscosity, brightness, color, etc.

I. 9. Characterization of an Emulsion

Like any galenic form, emulsions are subject to a number of controls; we can nevertheless refer to some of the controls that are typically used for simple emulsions.

I. 9. 1. Sense of emulsion

The direction of an emulsion (W/O or O/W) can be determined in three ways: **Conductivity** is the most common method. It consists of measuring the conductivity of the continuous phase. An aqueous phase containing an ionic surfactant such as SDS may have a conductivity greater than or equal to 1 ms. On the other hand, the lipophilic phase is almost zero. (Belhadj et al., 2015).

Water washability is a quick and simple test. A small amount of emulsion is deposited on the skin. If the emulsion is easily rinsed with water, it means that it is O/W (Stauffer, 2014). **The dye method** is based on the diffusion of dye powders in a sample. A hydrophilic and a lipophilic dye are used. The colorant that succeeds in diffusing in the emulsion tells us about the composition of the external phase (Stauffer, 2014).

I. 9. 2. Granulometric analysis

The granulometric analysis determines the dispersion size of the droplets. The main technique used is laser granulometry. In general, it is necessary to dilute the sample in order to obtain an analytic sample. However, care must be taken not to fall below the critical micellar concentration (CCM) of the surfactants in order not to destabilize the emulsion and distort the results. One of the possibilities used for measurements performed with the master size (Malvern) is to dilute the emulsion in the continuous phase rather than in distilled water (Belhadj et al., 2015).

I. 9. 3. Physical stability

The stability of the emulsion is studied in real time and in accelerated time. The real-time measurement is to verify the preservation of the dispersion under normal storage conditions in

order to observe its natural aging. The accelerated time study, on the other hand, consists of storing the solution under stress conditions (high temperature, temperature variations, centrifugal acceleration) in order to observe a faster dissolution (Stauffer, 2014).

I. 9. 4. Macroscopic properties

This test is based on the following criteria:

Appearance: depending on the nature of the constituent phases, it can be bright, satin, matte, transparent, translucent, or opaque.

Consistency: it has different qualifications; it is possible, for example, to describe a compact or flattening rigidity or a gelification, firmness, or shakiness.

Homogeneity : is primary and must be checked at the level of the appearance, whether smooth or granular, and the color (Benmeziane, 2014).

I. 9. 5. Forced sedimentation

A sample is subjected to constant centrifugal acceleration, preferably at a fixed temperature. Some methods propose combining the parameters by implementing centrifugations for different temperatures. Measurements performed during incubations or after centrifugation are either simply visual or more thorough (measurement of viscosity, granulometry, conductivity) to identify the mechanisms at stake in destabilization (Doumeix, 2011).

I. 9. 6. Reology

The rheological study allows for the quantification of the viscosity of the emulsion according to the cutting constraints applied (Doumeix, 2011).

I. 9. 7. Texture

Texture studies include firmness, cohesion, adhesion, and elasticity (Doumeix, 2011).

II. The skin

II..1. definition of the skin

At first observation , the skin is only the outer envelope of the person, the thin wall that protects it from the environment and its aggression. Yet its role in the life of the individual and in his psyche far exceeds this apparent superficiality. Indeed, the skin is a real organ with a complex set of structures and functions that will allow us to live, evolve, and understand the outside world (Neil, 2016). It contains many elements, essentially divided into three overlapping layers that correspond, from the surface to the depth, to the epidermis, to the dermis and then to the hypoderma (fig. I .14) (El Kaourib, 2015).

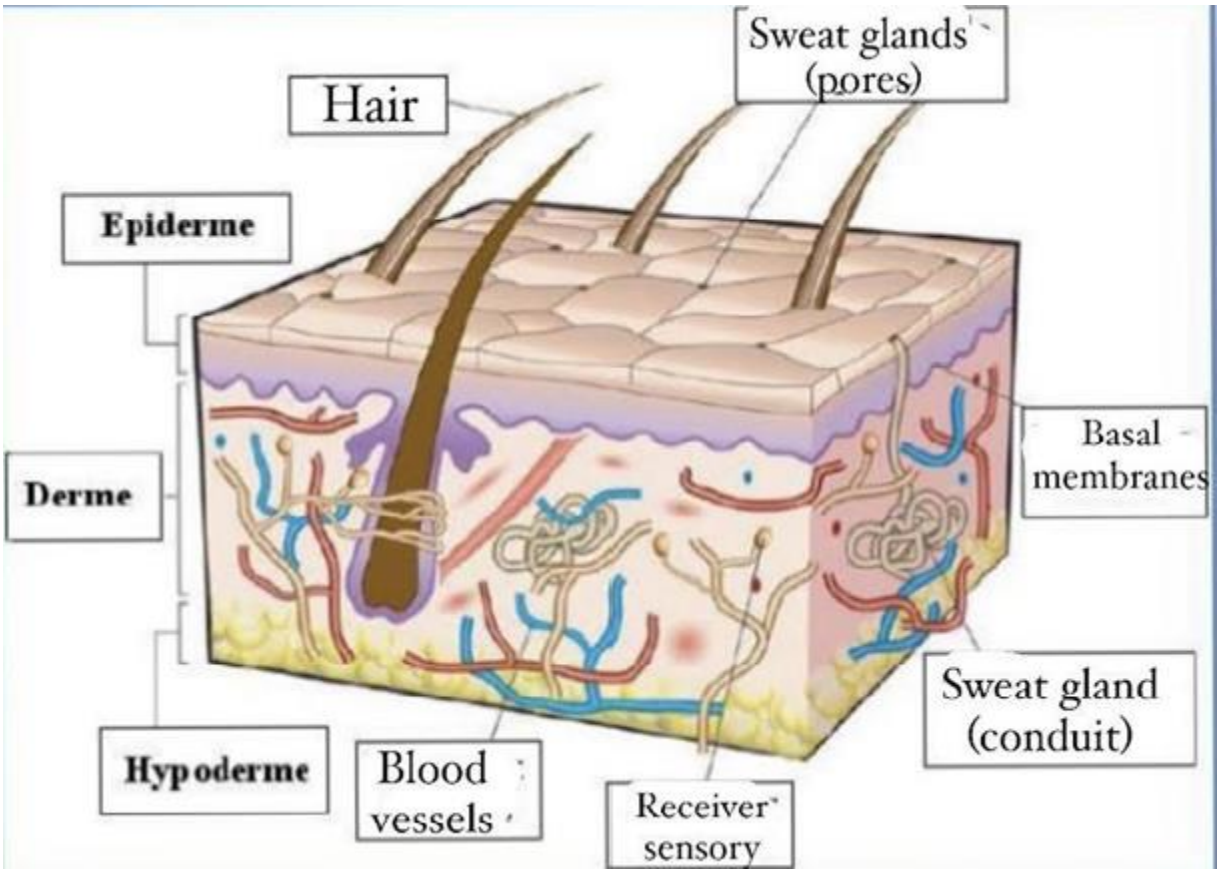


Figure I .14. Schematic presentation of the skin (El Kaourib, 2015**)**

II. 2. Roles of the Skin

II. 2. 1. Protection

The skin has a mechanical, chemical, thermal, and infectious barrier function. It can absorb external shocks and deform reversibly under the influence of external pressures. It limits the absorption of foreign substances and the loss of endogenous substances (Bejar, 2012).

II. 2. 2. Thermoregulation

The skin is the main interface through which the body controls its internal temperature. Hair and subcutaneous fat tissue serve as cold insulation. In addition, reduced skin blood flow by arterial vasoconstriction minimizes thermal losses (Bejar, 2012).

II. 2. 3. Metabolic Role

It is responsible for the synthesis of vitamin D and lipids (Bejar, 2012).

II. 2. 4. Absorption

Absorption cannot, in our view, be considered a function of the skin since its primary role is precisely to prevent a foreign substance from passing through it and entering its tissues. The

term “absorption” is used in physiology to refer to “a series of acts by which substances that were external to a living organism enter without traumatic injury inside that organism” (Cheurama, 2020). The sense of touch depends on the sensory receptors located in the skin, in very variable quantities depending on the areas of the body. Distributed in less sensitive areas such as the back, the tactile receptors, on the other hand, are very numerous and close to very sensitive zones like the tongue, lips, or the end of the fingers. (Larousse, 2009). These finishes will allow the perception of pain, tactile sensations, pressure, and heat. They each react to different stimuli and send the information back to the brain to interpret it.

II. 2. 5. Sensory role

The sense of touch depends on the sensory receptors located in the skin, in very variable quantities depending on the areas of the body. Distributed in less sensitive areas such as the back, the tactile receptors, on the other hand, are very numerous and close to very sensitive zones like the tongue, lips, or the end of the fingers. (Larousse, 2009). These finishes will allow the perception of pain, tactile sensations, pressure, and heat. They each react to different stimuli and send the information back to the brain to interpret it.

II. 2. 6. Immunological Role

Defense against microbial aggression, healing, etc. (fig. I. 15)

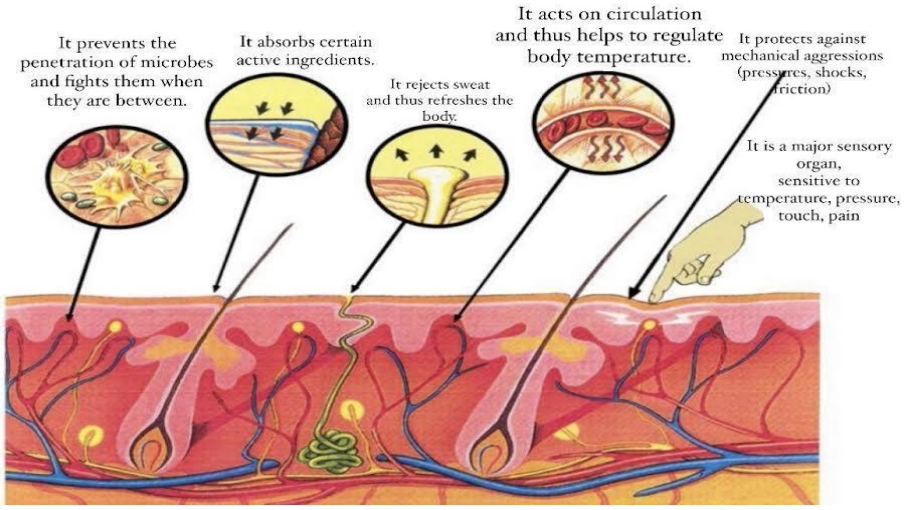


Figure. I. 15. the hypoderma (El Kaourib, 2015).

II. 3. Skin wound

II. 3. 1. Definition

A normal wound is defined as an interruption in the continuity of body tissue or a rupture of the skin barrier. In addition to the underlying organ damage that can occur during an accident, the wound can cause pathogenic germs to enter an organism and cause an infection. The main pathogenic risk is tetanus (Fortin, 2005).

II. 3. 2. Types of wounds

- **Chronic wound**

A chronic wound is a wound whose healing time is prolonged. A wound is considered chronic after 4 to 6 weeks of progression, depending on its etiology. Chronic wound causes include leg ulcers, scarring, diabetic wounds, and amputation sores (HAS, 2011).

Chronic wounds usually occur on already-healed tissues. They can be promoted by poor epidermal attachment to the dermis or vascular or metabolic abnormalities. They are often characterized by a large amount of collagen that reduces vascularization and oxygen supply (Ertzscheid et al., 2004).

- **The acute wound**

The acute wound has a normal healing time in the absence of a local or general factor that may delay healing (Battu et al., 2012).

II. 4. Classification of wounds

There is no standard classification for injuries. However, there are a number of different ways of classifying wounds that are useful in describing the injury for its ultimate management and healing (fig. I. 3). The most important factors. The assessment includes the nature of the injury causing the injection, the time, acute or chronic, and the depth of the lesions of the skin and underlying tissues (Percival, 2002).

II. 4. 1. Wound depth (Fig. I. 16)

- **First degree**

First-degree wounds (partial wounds) affect only the epidermis. They usually arise from a slight burn, sunshot, or slight abrasion and remain painful for a few days (Lindsay, 1996; Paletzet al., 1996).

- **Second degree**

Injury of the 2nd degree involves wounds whose epidermis is destroyed (surface) as well as part of the underlying dermis (deep) (François, 2014).

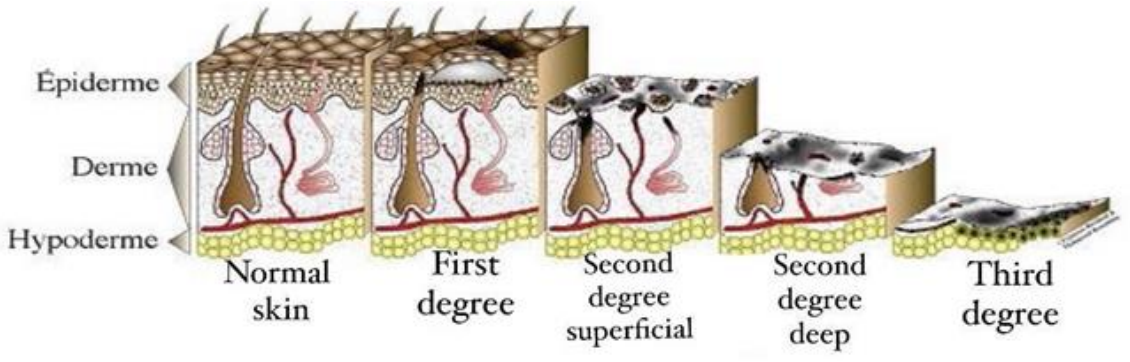


Figure I. 16. Classification of skin wounds by depth (Lindsay, 1996).

Third degree

Wounds of the third degree are characterized by the complete destruction of the epidermis and dermis. A heavy burn, cut, or deep abrasion destroys the nerve endings and makes these wounds painless (Lindsay, 1996).

II. 4. 2. Extent of the Wound

The extent of a wound is a major parameter when treating an injured person. Thus, therapeutic procedures as well as the prevention of infections will differ if it is a local injury or a lesion that affects a significant proportion of the body surface.

II. 4. 3. Nature of the Wound

The nature of the aggression produces a wound whose characteristics influence its presentation and its natural and therapeutic healing. As a result of a burn, reepithelialization begins later so that the wound remains open longer. Thus, they will be treated differently: a hot, cold, or chemical burn; an incision; a scratch (Winter, 1972).

II .6. Skin scarring

II. 6. 1. Definition

Skin healing is a very complex, dynamic biological phenomenon that takes place after an injury in order to restore the integrity and homeostasis of the skin as quickly as possible. The proper closure of a lesion is possible thanks to the cooperation between many soluble mediators (growth factors and cytokines), the introduction of different cell types (inflammatory, endothelial, blood, epithelial, and immune cells), and interactions with the extracellular matrix (Fanny, 2009).

II. 6. 2. Types of scars

- **Normal scars**

A perfect healing gives a scar called normal, that is, flexible to palpation, with no difference in color from the surrounding skin and almost invisible. But many factors can influence healing and promote certain complications, which are sometimes difficult to treat.

- **Abnormal scars**

The abnormal course of the mechanisms of healing can lead to pathological scars that appear in different forms. For example, chronic wounds, retractile scars, and cheloid scars are the result of a delay, alteration, or excess of this healing process, respectively. (Ferraq, 2007).

II. 6. 3. Stages of Healing

The healing of a wound takes place according to a well-defined process. It consists of three main phases (fig. I. 17) :

-

+Deterrence phase (0 to 4 days)

It prevents the extension of the wound through the combination of two processes:
- In a vascular process, the bleeding accumulates to form a blood clot, which, when dried, forms a crust that will close the wound and protect the deep tissues.
-An inflammatory process that allows the wound to be cleaned by removing dead cells and potentially harmful microorganisms (Geoffre, 2018).

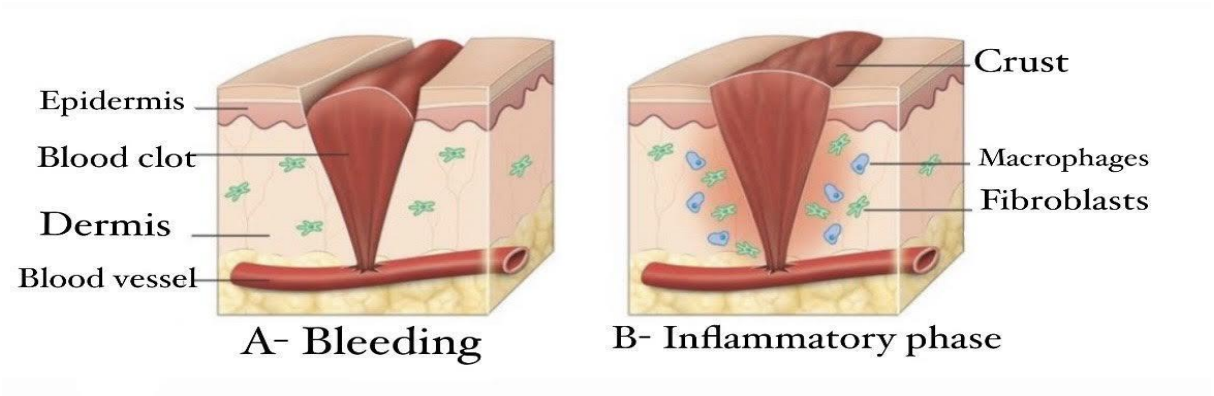


Figure I. 17. The deterrence phase (https://www.elsevier.com/en/connect/ifsiinfirmier/plies) healing-and-bandages 21/02/2019).

- Regeneration phase (2 to 10 days)

This stage is often referred to as the bounce phase because it corresponds to the development phase of the tissue that will fill up the loss of substance (fig. I. 18). It results in epithelialization or re-epidermization (Geoffre, 2018).

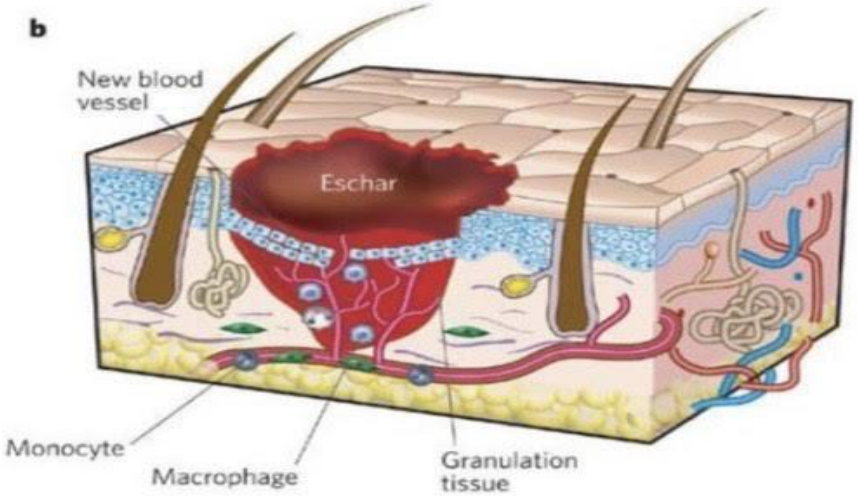


Figure I. 18. The regeneration phase (Gurtner et al., 2008).

- Remodeling phase (3–6 semaines)

The remodeling phase begins after the wound is closed (fig. I. 18), with an epithelial tissue that produces a scar whose remodeling may take several months to result in the so-called definitive scar (Geoffre, 2018).

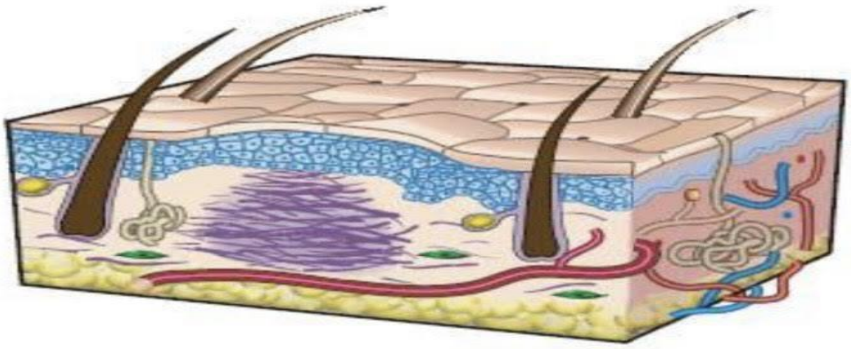


Figure I. 19. The remodeling phase (Gurtner et al., 2008).

II.7.Factors influencing scarring healing

A scar will never be the same from one person to another. Several factors influence the speed and degree of their healing (table I. 1).

Table I. 1. Factors influencing scarring healing (KASSA et al., 2015;

Local factors	General factors
* Localization, environment, and hydration of the wound. * Degree of infection of the wound. * The presence of foreign bodies (purification of the wound by foreign objects can lead to infection and prevent rapid healing). * Vascularization of the wound: good vascularization is essential for good healing.	* Localization, environment, and hydration of the wound. * Degree of infection of the wound. * The presence of foreign bodies (purification of the wound by foreign objects can lead to infection and prevent rapid healing). * Vascularization of the wound: good vascularization is essential for good healing.

Addressing skin burns and wounds effectively is crucial for preventing complications and promoting healing. While conventional treatments such as antiseptics and bandages are commonly used, there is a growing interest in alternative and complementary approaches. Medicinal plants are considered an important source of new chemicals with significant therapeutic effects. In recent years, there has been increasing interest in the study of these plants (Belmekki et al., 2013). This exploration is particularly relevant for the genus *Teucrium*, which includes more than 300 species present in the Mediterranean basin, with 21 species found in Algeria, growing spontaneously in various parts of the globe (Fertout-Mouri et al., 2017). Belonging to the *Lamiaceae* family, these species are typically herbaceous or arbustive, annual or perennial, and often aromatic (Lemeailbi, 2019). Understanding how these medicinal plants can aid in the treatment of burns and wounds offers promising insights into more holistic and accessible healthcare solutions.

III. Medicinal plants

A medicinal plant is defined by the French Pharmacopoeia as a "plant drug within the meaning of the European Pharmacopeia of which at least part has medicinal properties". A

"plant drug" is a plant or part of a plant, used in the state, either most often in the dried form or in the fresh state (Mohammedi, 2013).

III .1. Botanical description

The genus *Teucrium*, also referred to as the germandrées, includes approximately 260 species of herbaceous plants of the family Lamiacées. *Teucrium polium* is a very variable species: many subspecies have been described, some of which are sometimes classified as species (Hinda, 2017).

It is a plant of 10 to 35 cm and exhales a strong, aromatic, pleasant smell. Living with robust stems, long woody, straight or straightened, branched, with branches covered with cotton hairs. The white flowers, rarely purple, bloom from May to August (Amina, 2018). The flowers are white or yellowish in dense clusters at the top of the branches. Their characteristic is that they have only one lip, the lower lip, gathering the five welded petals (Hammoudi et al., 2015). The cup, covered with short, cotton hair, has five unequal teeth, the upper of which is larger and obtuous at the top and the lower sharp (fig. I. 20); these teeth are about one-third the length of the rest of the cup (Amina, 2018).

The corolla has obtuous and oval lobes, the lower larger; the upper lobes are hairy. Stamines are not wrapped around themselves after flowering. The four parts of the ripe fruit are brown and ornamented to their surface (Quezel et Santa, 1963).



Figure I. 20. Wild plant *Teucrium Polium*

III. 2. Systematic position

According to Quezel and Santa (1963), the system of *Teucrium polium* L is as follows :

- Reign : Vegetable
- Class : *Magnoliopsida*
- Order : *Lamiales*
- Family : *Lamiaceae.*
- Genre : *Teucrium*
- Species : *Teucrium polium* L.

III. 3 .Vernacular names

In Arabic : Kayatta, Djaâda (Algeria), Takmazzut (Touaregs-Algeria), Jaaida (Morocco), Hachichetelrih (Lebanon) (Hasni et Hayet, 2017).

In French : grey and white germanderie, tomenteous germandrée, Polio de montagnes (Rasekh et al., 2005).

III. 4. Geographical distribution:

Teucrium polium is an area that grows in the wild, mainly in North Africa, in southwestern Europe (fig. I. 21), it is a perennial bush well adapted to the Mediterranean climate with warm and arid environments (Malki et Yahia, 2017)



Figure I. 21. Répartitiongéographiquedel'espèce *T.Polium L* In Algeria (Bentahar, 2018)

III. 5. Chemical composition :

Several researchers evaluated the chemical composition of *T. polium* developed in different geographical sectors. Most of these studies, based on the analysis of the extracts by gas phase chromatographic methods, indicated the presence of several compounds, including mainly flavonoids, polyphenol (Proestos et al., 2006; Djabou et al., 2012), iridoids, tannins, alkaloids (Shakhanbeh et Adiguzel, 2001; Parsaee et Shafiee-Nick, 2006), and essential oils, mainly mono-terpene hydrocarbons (Belmekki et al., 2013; Kabouche et al., 2007; Moghtader, 2009) and oxygenated sesquiterpenes (Proestos et al., 2006; Stefkov et al., 2011), diterpenes with a neoclerodane skeleton, and more than 220 diterpenes (Piozzi et al., 2005).

Additionally, other studies have shown that *T. polium* contains glycosides such as verbascoside and poliumoside (known as phenylethanoid) in the aerial parts of the plant (Rasekh , H. , M.Khoshnood-Mansour khani,and M.Kamaline jad).

Several researchers identified six flavone aglycones: luteolein, apigenin, diosmetin, cirsiliol, ciresimaritine and cirsilineol (Stefkov et al., 2009), while the steroid compounds were isolated (Kabouche et al., 2007; Moghtader, 2009). The analysis of the active ingredients reveals the presence of saponins (Hassan et al., 2007), tannins and alkaloids (Shakhanbeh et Adiguzel, 2001).

III. 6. Biological, pharmacological, and therapeutic effects:

Species of *T. polium* have been used as medicinal herbs for more than 2000 years (Bendif, 2017). Experimental research has shown that the plant *Teucrium polium* L has specific biological, pharmacological and therapeutic effects such as diuretic, diaphoretic, inotropic and chronotropic, tonic, antipyretic, cholagogue, and anorexic (Khleifat et al., 2002; Niazmand et al., 2008).

For a long time, germander has been used as an infusion to combat gout, rheumatism, chronic bronchitis and abundant mucosities. In a mouth bath, it heals gingivitis, and in a lotion, it accelerates the healing of wounds (Gharaibeh et Salhab, 1988).

In traditional African medicine, this species is used in times of stress, as it allows you to relax, be serene, and be full of energy. It allows the relaxation of the muscles by increasing their strength and relieving these pains (Abdollahi et al., 2003), reducing anxiety, and combating fatigue and aggression (Amina, 2018). In addition, it promotes sleep and also helps to stimulate memory and increase concentration and lucidity (Lagnika, 2005). Anti-stress and antioxidant properties allow it to combat skin aging (Hammoudi et al., 2012). *Teucrium* is a medicinal plant that allows resistance to antibiotics, can be used to protect against

pathogens, and can serve as an antimicrobial substance (Belmekki et Bekhechi, 2013; Patel et al., 2006). So it has an antibacterial effect.

This plant has led to a decrease in the level of fatty acids and a blockage of peroxidation (Tepe et al., 2011) at the erythrocyte level, so it has shown anti-inflammatory, antinociceptive, antispasmodic (Abdollahi et Monsef-Esfehani, 2003; Menichini et al., 2009; Kaur et Arora, 2010), antifungal (Esmaeili et Yazdanparast, 2004), anti-cancer (Stefkov et al., 2003; Menichini et al., 2009), hepatoprotective (Shtukmaster et Bomzon, 2010), hypolipidemic (Stefkov et al., 2003), antihypertensive (Niazmand et al., 2011), and hypolipemic effects (Rasekh et Kamalinejad,2001).

Germander has been used for various types of pathological conditions, such as gastrointestinal disorders and rheumatism (Dehghani et al., 2005), against jaundice, anti-anorexia, spasmic and gastric colic controls, and stomach disorders (Kaur et Arora, 2010; Kasabri et Hamdan, 2011). It may have some clinical interests : liver diseases, low blood pressure, fever; it's tuareg aspirin (Kaur et Arora, 2010; Kasabri et Hamdan, 2011). Its decoction is widely used as a hypoglycemic agent in normoglycemic rats compared to streptozotocine-induced hyperglycemics (Shtukmaster et Bomzon, 2010). However, safety tests are required to confirm its hypoglycemic action (Gharaibeh et al., 1988).

Among the cytotoxic effects, we find that the results show that the ethanol extract of *T. polium* has a very effective anti-tumoral potential by inhibiting, in vivo, the generation of colonies of a few cell lines in the middle of agarose and suppressing their growth (Nematollahi-Mahani et al., 2007). However, the aquatic extract of *T. polium* increases the cytotoxicity negotiated against N-methyl-N-nitro-Nnitro soguanidine on primary hepatocyte cell cultures in rats and significantly reduces mitotic index and necrotic cells (Khader et Bresgen, 2007).

IV. Natural cosmetics

IV. 1. Defnition

There is no official definition of organic cosmetics. What is commonly called "organic cosmetics" refers to a family of products composed of natural ingredients or of natural origin (in a more or less important proportion depending on the brand), unlike "conventional" cosmetic products manufactured mostly from synthetic ingredients. Organic cosmetics limit or exclude the use of substances that can cause harmful effects on the user (allergies, cancer, etc.) or on nature (animal testing, use of polluting manufacturing processes, etc.) (Morillon, 2008).

Natural cosmetic products are very similar to "native" products, such as traditional herbal medicine, which uses almost raw raw materials. They mainly undergo primary mechanical and chemical transformations, such as distillation, extraction, cooking or filtration, fermentation

and oxidation, percolation, and dessiccation, leaving few residues that are easily recyclable and biodegradable. Schematically, we find in natural and organic cosmetic products by extension a majority of ingredients from the plant world (plants, fruits, flowers, etc.) exploited in different forms (essential oils, vegetable oils, powders, etc.), but also substances of animal origin produced naturally and without abuse to obtain them (honey, beeswax, milk, eggs), and some mineral resources (clays, silica, etc.) To be awarded the organic name, cosmetic products must meet several criteria relating to their production, manufacture, and conservation (Audrey, 2014).

IV.2. composition of natural cosmetics

The main difference in composition between "classic" cosmetics and "organic" cosmetics is the excipient. A conventional cosmetic product is mainly made up of this base, which is responsible for conveying, among other things, the active ingredients responsible for the desired effects on the skin. In an organic product, it is natural ingredients such as vegetable oils of argan, hazelnut, almond, or shea butters that will play this role. However, they are real mines of vitamins and fatty acids Essentials act in synergy with the natural active ingredients added to the product (Demange, 2007).

Organic cosmetics therefore claim a high content of active raw materials; many components will have a primary role as an excipient but will also bring additional beneficial activity to cosmetics. We will distinguish three types of classic ingredients used in the composition of organic cosmetic products: raw materials from the plant kingdom, the animal kingdom and from the mineral kingdom. However, it will not be possible to list all the components that may appear in the composition of organic cosmetic products; manufacturers commonly use "exotic" components.

Chapter II
Material and Methods

Our work was carried out in chemistry laboratory at the University of Medea The aim of this work is to formulate an emulsion based on natural products, and obtain a range of natural products made with natural emulsifier that we manufactured in the laboratory with natural materials. The emulsifier produced was used to prepare a healing-anti-bruising cream by hot emulsification and the one-in-pot method. The healing efficacy study was tested on laboratory mice.

II. 1. Materials and products

II. 1. 1. Materials

As with any experimental work, the implementation of this work required the use of much laboratory equipment, including measuring, heating, and stirring apparatus, as well as glassware (table II. 1).

Table II. 1: Materials used

Appliances	The glass shop
-Electric scale	-The bechers
-mechanical agitator	-Spatulas and capsules
-Bath-marie	- Graduated pipettes
-Thermometer	- Test boxes
-pH meter	-Crystals
-Conduct meter	- volumetric flask
-Optical microscope	-Erlen Meyer
-Centrifuge	-Assay Tube
-Etuve	-Blades
-Refrigerator	-The lamelle
-Rota-evaporator	
-Mixer arm	
-Muffle furnace	
-Heating plate-Spectrophotometer	
-Infrared	

II. 1. 2. Products used

Table II.2 shows the different chemicals we used in our experiments.

Table II. 2. Chemicals used

Products	Main Characteristics
Distilled water	The good preparation water is very soft, at best distilled or demineralized, and germ free.
Vegetable Glycerin	-Protection and barrier against aggression; - The restoration of natural defenses; - Hydrating
The Xanthane gum	-an insipid, whitish powder. It is cold-soluble in water, in milk, and in alcohol. - a gum with high thickening and suspension power, which allows the obtaining of solutions with high viscosity.
Bee wax	-It is a particular natural wax secreted by honey bees. It is used in the manufacture of medicines because of its antibacterial properties, (https://fr.wikipedia.org/wiki/Beeswax).
Olive oil	- It is a vegetable oil rich in vitamins, including A, C and D, which provide energy. It moisturizes the skin.
lentisk oil	-powerful and aromatic -Lens vegetable oil soothes and repairs sewn skins -calms irritations and relieves small skin problems
Cetyl alcohol	-a high thickening and suspension power, which allows the obtaining of solutions with high viscosity. -soluble in oil and insoluble in water.
Citric acid	- Used for adjusting the pH of emulsions.
Rose water	-moisturizing, antioxidant and antibacterial properties.
Soy lecithin	-very good stabilizing and emulsifying agent -it avoids the separation of ingredients
Almond oil	-Emollient, it nourishes the skin and protects it from drying. Relaxing and strengthening, - it activates the repair of the skin. Soothing, - it calms itching and irritation.

Ethanol	-colorless, volatile, flammable and mixable with water in all proportions
Sodium carbonate	-odorless white crystalline powder or lumps
Follincio-calteu	-used for the measurement of total phenols (folin ciocalteu) in natural products, the basic mechanism of which is a reaction
DPPH	-Used to determine antioxidant activity of crude extracts or purified compounds from plants
Gallic acid	-is a monomeric phenolic compound solid, and colorless, which is bound to sugars and belong to group of hydrolysable tannins
Aluminium cloride	-white to gray powder with a spicy smell. Corrosive to tissues and toxic by ingestion.

II. 2. Methods

II. 2. 1. Extraction of oily *Teucrium polium L* macerated in lentisk oil :

- Weigh Xg of *Teucrium polium* L
- Place the weighed plant powder in a bottle and add Xml of lentisk oil under gentle agitation.
- Heat the mixture in a bath-marie at 80°C for 1 hour.
- Leave to macerate at room temperature in the dark for four days.
- Filter and collect the prepared oils in clean, dark bottles (photo II.1).



Picture II. 1. Oily macerate of *Teuricum polium* L in lentisk oil

II. 2. 2. Ethanolic extract of *Teucrium polium* L *preparation*

- Weigh X g of plant;
- In an erlen Meyer, weigh the plant powder into a mixture of distilled water and ethanol (25:75 w/w).
- Shake gently;
- Heat the mixture in a water bath at 80°C for one hour.
- Macerate at room temperature, in the dark, for four days.
- Filter and recover the ethanolic extract in clean, dark bottles.



Picture II. 2. Ethanolic extract of *Teucrium polium* L preparation

II. 2. 2. 1. Phytochemical screening

The prepared ethanolic extract of *Teucrium polium* L was used to test various phyto constituents present in it. Different chemical reagents were prepared and specific test, for specific phyto chemicals was done. These various tests were qualitative and hence termed phyto chemical screening. The tests were done by following standard procedures based on journal articles.

Test for tannin :

To 1ml of the ethanolic extract, 2 ml of water, and 3-4 drops of 1% FeCl3 were added, blue color was seen for gallic tannins, appearance blue-black coloration, and the presence of catechol tannin turned the solution green or blue green.

Test for reducing sugar :

To 1 ml of plant extract, 2mL of water, and 20 drops of Fehling's solution were added and heated. The presence of reducing compound was indicated by the appearance of brick red precipitation.

Test for quinones :

1g of vegetable powder is macerated in 30ml of ethylether for 24h, after filtration, add a few drops of sodium (NaOH) 1N. The deep red or yellow color indicated the presence of quinone.

II. 2. 2. 2. Total polyphenols dosage

Calibration curve, the procedure for obtaining the calibration curve consists of preparing :

1. An aqueous stock solution of gallic acid at a concentration of C0 = 0.1 g/l, preparing a volume of 100 ml.
2. A solution of folin- ciocalteu at a concentration of 10% (v/v).
3. A 7.5% (w/v) sodium carbonate solution.

A series of gallic acid solutions at different concentrations were prepared from the stock solution, then a 2ml volume of each solution was mixed with 2ml of the folin- ciocalteu solution and 2ml of the sodium carbonate solution.

The reaction mixture was incubated for 40 minutes at room temperature in the dark. Absorbance readings at 750 nm and 765 nm were taken using a UV spectrophotometer. The blank was made up of 2ml folin- ciocal reagent, 2ml distilled water and 2ml sodium carbonate solution.

Total polyphenols were determined at the same time as the gallic acid calibration curve and under the same conditions.

II. 2. 2. 3. Flavonoid assay

To assess the flavonoid content of plant extracts, we proceeded as follows:

1. Prepare a solution of *Teucrium polium L* extract for a mass of 10 mg of extract diluted in 100 ml of distilled water.
2. Prepare a series of solutions of *Teucrium polium L* extract at different concentrations ranging from 0.01mg/L to 0.02 mg/L,
3. Prepare 2% (w/v) aluminum chloride solution.
4. Under magnetic stirring, mix a 2ml volume of the different *Teucrium polium L* extracts solutions and a 2ml volume of the aluminum chloride solution,

After incubation in the dark, for 10 minutes, at room temperature, absorbances were read at 430 nm using a UV spectrophotometer. The results were read against a blank consisting of 2 ml distilled water and 2 ml AlCl3 aluminum chloride.

II. 2. 2. 4. DPPH assay

The DPPH free radical is a long-lived organic nitrogen radical with a deep purple color .When a DPPH solution is mixed with an antioxidant, its color turns from purple to yellow of the corresponding hydrazine. The reducing ability of antioxidants toward DPPH can be evaluated by monitoring the decrease of its absorbance at 515– 528nm.Theresults are expressed as IC50 or as% scavenging of DPPH at a fixed antioxidant concentration for all the samples (Brand-Williams etal.,1995;Sanchez-Mareno, 2002).

Preparation of DPPH solution :

DPPH solution was prepared bytaking4 mg of DPPH using a chemical balance dissolving with 100 ml 96% ethanol, and finally kept in dark for 3 hours at 4°C.

DPPH assay procedure

To assess the DPPH content of plant extracts, we proceeded as follows:

1. Prepare a solution of *Teucrium polium L* extract for a mass of 0.1g of extract diluted in a mixture distilled water/ethanol (25: 75).
2. Take 50ml flasks, add one volume of the stock solution and make up to 50ml with ethanol.
3. Under magnetic stirring, mix 1ml of the various *Teucrium polium L* extract solutions and a 2ml volume of DPPH.
4. After incubation, for 30 minutes at room temperature in the dark, absorbances were read at 517 nm using a UV spectrophotometer. Results were read against a blank consisting of 3ml ethanol and the control 1ml distilled water and 2ml DPPH.

The inhibition ratio(%) was obtained from the following equation:

Inhibition ratio (%) = (A1−A2)×100⁄A1,

Where

A1 is the absorbance of the addition of ethanol in stead of testing sample

A2 is the absorbance of testing sample solution

II. 2. 2. 5.Acute toxicity assy

The acute toxicity test was carried out according to the following protocol :

The Swiss albino mice were divided into 3 batches of 6 individuals (3 males and 3 females) and acclimatized for one week before starting the experiment. They were kept fasting for 18 hours before administration of the various ethanol extracts:

- The first batch (control) received physiological water,
- Group 2 received a single oral administration of the extract at a dose of 400 mg/kg, i.e. 12 mg for a mouse weighing around 30g.
- Group 3 received a single oral administration of the extract at a dose of 800 mg/kg, i.e. 24 mg for a mouse weighing approximately 30g.

Changes in general behavior or mortality of mice in each batch were monitored for 14 days.

II. 2. 2. Biomass Valorization :Preparation of activated charcoal

- weigh Xg of plant residue
- put in the oven a mouffle, 3 hours at X.



Picture II. 3. Preparation of activated charcoal (original)

II. 2. 3. Preparation of emulsions

II. 2. 3.1. Potassium olivate preparation

- Weigh X g of olive oil.
- Prepare a solution of KOH (Xg water + Xg KOH).
- Add the KOH solution to the olive oil.
- Mix warmly until a soft paste is obtained.



Picture II. 3. Potassium olivate (original)

II. 2. 3. 2. Emulsifying wax

- Weigh Xg of beeswax, and dissolve it in a marie bath;
-Prepare a solution of NaOH
- Mix the NaOH solution with dissolved beeswax
- Mix until a solid paste is obtained;
- Leave the preparation at room temperature for three weeks
- At the end of the reaction, grind the resulting product.



Picture II. 4. Emulsifying wax preparation (original)

II. 2. 3. 3. Emulsifiers characterization

- Fourier Transform Infrared Spectrophotometer (FTIR) characterization

FTIR spectroscopy is an analytical technique that measures infrared absorption by molecular bonds in a material. Unlike conventional infrared spectroscopy, which measures the intensity of infrared light emitted or reflected at different wavelengths. FTIR spectroscopy measures the intensity of infrared light after it has passed through a sample, using Fourier interferometry. The result is a faster, more accurate spectrum.

Procedure

FTIR spectra were obtained by preparing pellets of olive oil, olivate potassium/KBr, emulsifying wax /KBr with a proportion of 1% (mass/mass). The pellets were prepared by grinding the substance to be analyzed in the presence of KBr, then compressing the mixture under a press. Finally, the pellets were sent for FTIR analysis, where infrared absorption spectra were recorded in the 4000-600 cm^{-1} wavelength range.

II. 2. 4. Emulsions formulation

The aim of our work is to prepare the emulsifiers potassium olivate and emulsifying wax, and to study their ability to give stable emulsions. To this end, we have opted to produce emulsions using the experimental design method. This method will enable us to vary several parameters at the same time with a minimum of experimentation. Table II. 4 shows the matrix of experiments carried out to study the effect of the two emulsifiers prepared during our work.

Table II. 4: The experimental matrix showing the different compositions of the emulsions to be prepared using the two emulsifiers prepared in our laboratory

-= minimum quantity , += maximum quantity , 0= means quantity

Experience	Soya Lecithin	Emulsifying wax	Cethyl alcohol	Karite Butter	Potassium Olivate	Xanthangum	stabilité
1	+	+	+	-	+	+	**Stable**
2	-	+	+	+	+	-	**Stable**
3	-	-	-	+	+	+	**Unstable**
4	+	-	-	-	+	+	**Unstable**
5	-	+	+	-	-	+	**Stable**
6	+	-	-	+	-	-	**Unstable**
7	+	+	+	-	+	-	**Stable**
8	-	-	-	-	-	-	**Unstable**
9	**0**	**0**	**0**	**0**	**0**	**0**	**Stable (40%)**

Note that the aqueous phase was set at 70%, while the oil phase was added in sufficient quantity to reach 30%.

II. 2. 3. 1. Emulsion composition

Table II. 5 shows the different phases of the emulsions to be prepared and their compositions.

Table II. 5. Phases and composition of the emulsions to be prepared

		The Composition	Percentage (%)
Aqueous		**Distilled water**	**QS for 70 (%)**
		Vegetable glycerin	**10%**
		Xanthangum	**0.4%**
Oily	**Oil**	**karitebutter**	**1 (%)**
		Olive oil	**QS for 30 (%)**
	Emulsifier	**Soy lecithin**	**5 (%)**
		Emulsifying wax	**2.5 (%)**
		Cethylic alcohol	**2.5 (%)**
		Potassium olivate	**5 (%)**

II. 2. 3. 2. Emulsification

Emulsion preparation begins by weighing the ingredients of each phase according to the quantities shown in Table II. 4. The diagram shown in Figure II.2 summarizes all the formulation stages.

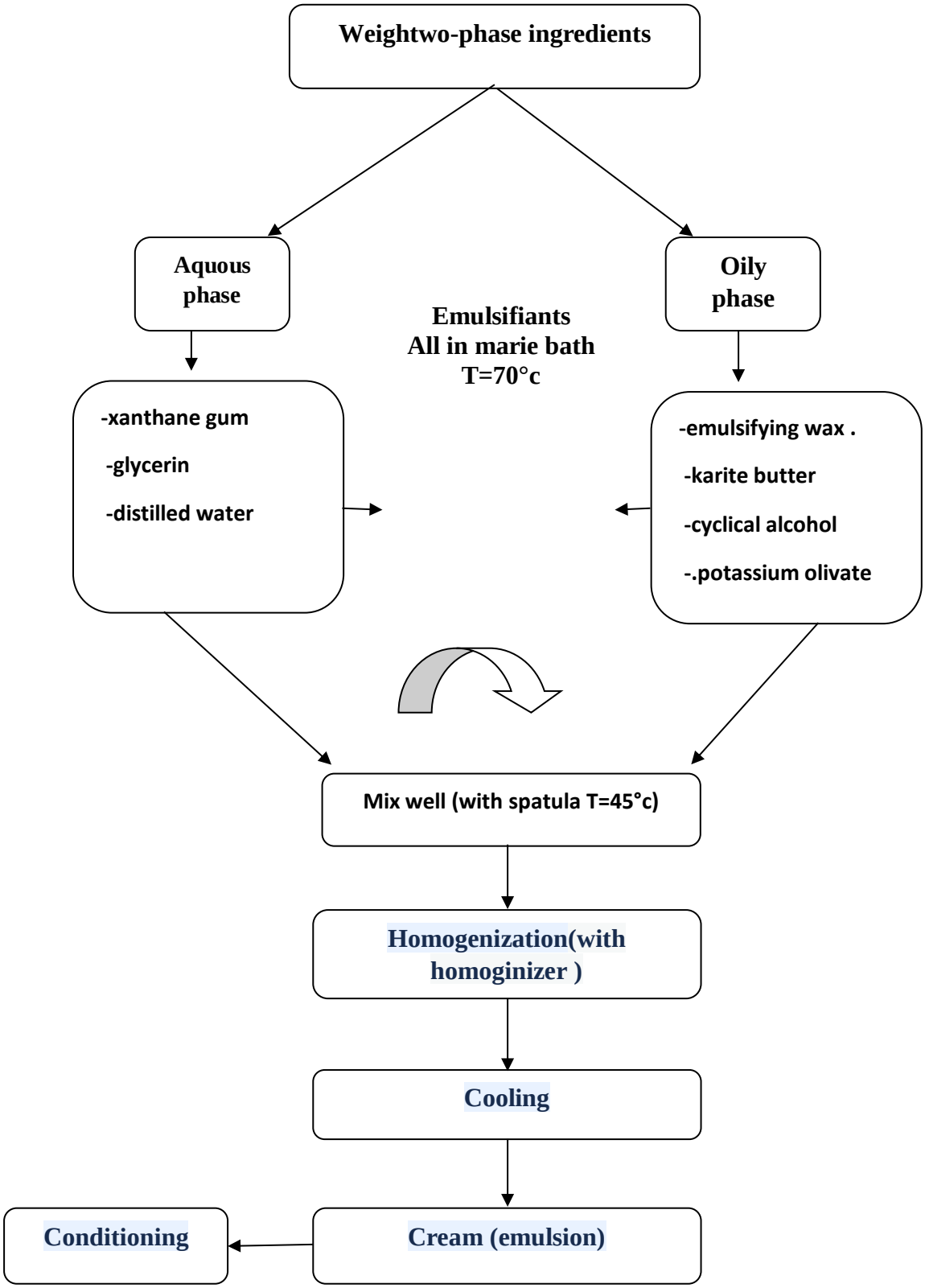
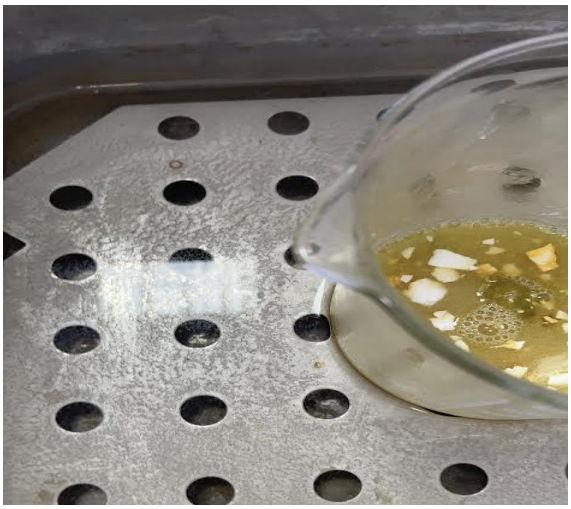


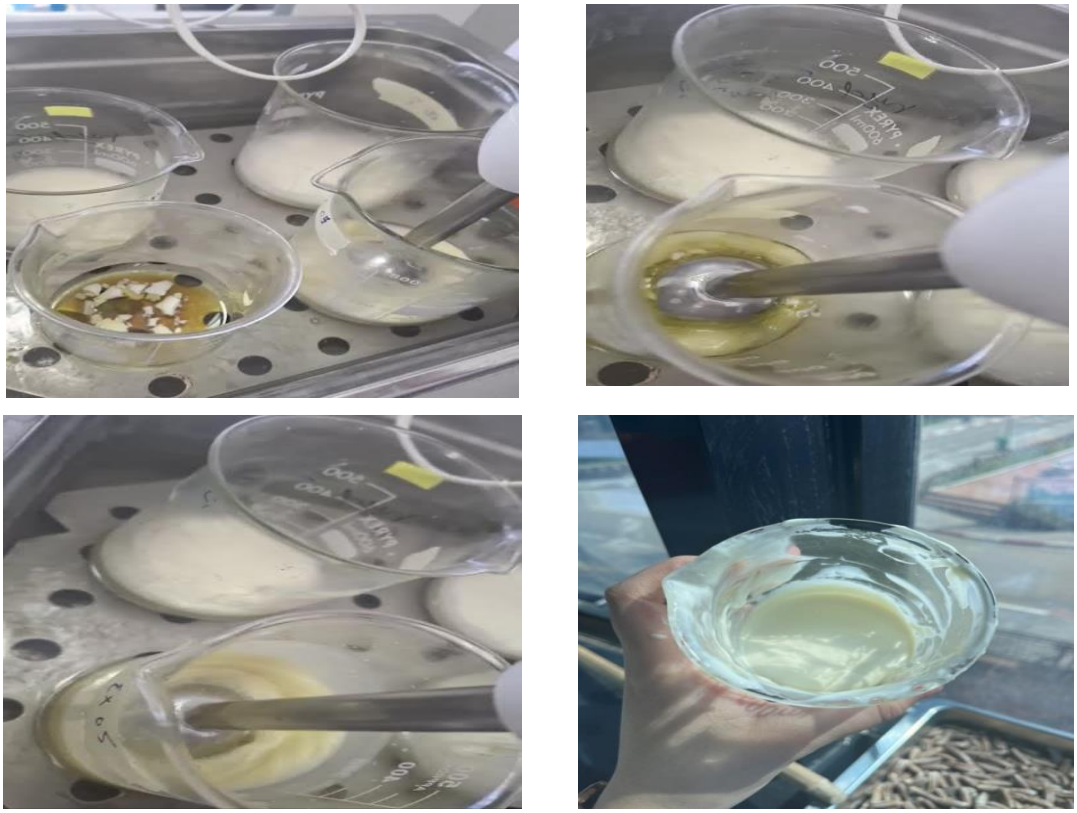
Figure. II. 2. Organigram of the preparation stages of an emulsion formulation

Then heat the two phases in a marie bath at 80°C until all the ingredients dissolve (picture II.5).



Picture II. 5. Heating of the two phases of the emulsion

After melting and when both phases reach 80°C, pour the oily phase into the aqueous phase and leave the mixture in the marie bath and stir well until a homogeneous mixture is obtained (picture II.6)



Picture II. 6. The steps of preparing a hot emulsion.

Once the mixture is homogeneous, transfer it to a cold water bath and continue stirring until a smooth and homogenous cream is obtained. (picture II.7).



Picture II.7.Emulsion cooling

Based on the results of the experimental matrix, we selected the experiments that gave the most stable emulsions, and tried to see the behavior of different emulsifiers and the influence of their different quantities on emulsion stability, with the aim of finding the right blend of natural emulsifiers to give the most stable emulsion possible. The first series of experiments is presented in table II. 6,which enables us to study the effect of xanthan gum and emulsifying wax on the stability of the emulsions selected.

Table II 6. Series of experiments carried out without Xanthan gum, and Emulsifying wax

Experience	Soya Lecithin	Cethyl alcohol	Potassium Olivate	Stabilité
1	+	+	+	**Stable**
5	-	+	-	**Stable**
9	**0**	**0**	**0**	**unstable**

In the second series of manipulations, experiments were carried out without the emulsifying wax but with the addition of xanthan gum (table II. 7).

Table II. 7: Series of experiments carried out withoutEmulsifying wax

Formule	Soya Lecithin	Cethyl alcohol	Potassium Olivate	Xanthan gum	stabilité
1	+	+	+	+	**stable**
5	-	+	-	+	**stable**
9	**0**	**0**	**0**	**0**	**stable**

It should be noted that experiment 9 was carried out to see the influence of xanthan gum in the presence and absence of cethyl alcohol.

In this series of experiments (Table II. 8), we repeated Experiment 1, but this time removed the potassium olivate to see its effect on emulsion stability. Experiment B was carried out in the absence of cetyl alcohol.

Table II. 8 :Series of experiments carried out whitout potassium olivate and Emulsifying wax

Formule	Soy Lecithin	Cethyl alcohol	Xanthan gum	Stabilité
1	+	+	+	**Unstable**

Table II. 9, shows a formula under the conditions of experiment N°1. Experiment N°2 , on the other hand, was repeated with the addition of xanthan gum and potassium olivate.

Table II. 9 :Series of experiments carried outwith Emulsifying wax

experience	SoyLecithin	Emulsifying wax	Cethylalcohol	Potassium Olivate	Xanthangum	stabilité
5	-	+	+	-	+	**stable**

Table II. 10, shows a formula under the conditions of experiment N°1 without cethyl alcohol, and soy lecithin for experiment N°2.

Table II. 10 :Series of experiments carried out without cetyl alcohol

experience	Soya Lecithin	Emulsifying wax	Potassium Olivate	Xanthan gum	stabilité
1	+	+	+	+	**unstable**
5	-	+	-	+	**unstable**

Table II. 11. Series of experiments carried out with all ingredients

experience	Soya Lecithin	Emulsifying wax	Cetyl alcohol	Potassium Olivate	Xanthan gum
1	+	+	+	+	+
5	-	+	+	-	+

II. 3. 3. Physicochemical characterization of prepared emulsions

II. 3. 3. 1. Organoleptic properties (The macroscopic observation)

The macroscopic observation of emulsions is one of the user acceptability tests. The examination is done with the naked eye directly on the formulated emulsions. The main characteristics observed are: color, smell, physical aspects, consistency, and homogeneity of the preparation (Moussaoui and al., 2004).

II. 3. 3. 2. Microscopic examination

It is a physical and fundamental control; its objectives are:

- ✓ To determine the size, shape, and homogeneity of the distribution of formulations.
- ✓ To verify the absence of abnormal particles in suspension or the presence of air bubbles.
- ✓ The coalescence phenomenon.
- ✓ The change of emulsion phase (Adali and al., 2015).

Operating Mode

- ✓ Well spread a quantity of the prepared emulsion between the blade and the clean blade
- ✓ Observe X40 enlargement and note the distribution of the blood cells, their shape, and their size.

II. 3. 3.3. Determination of pH

pH control is important because the physical stability of emulsions is largely dependent on this parameter (Doumeix, 2011). This is determined with colored reagents or using a pH meter. Once the device is calibrated, the electrodes are rinsed with distilled water. The electrode isinserted directly into the emulsion, and the pH value is read, which is displayed on the device screen.

II. 3. 3.4. Sense of emulsion

- ✓ **Determination of conductivity**

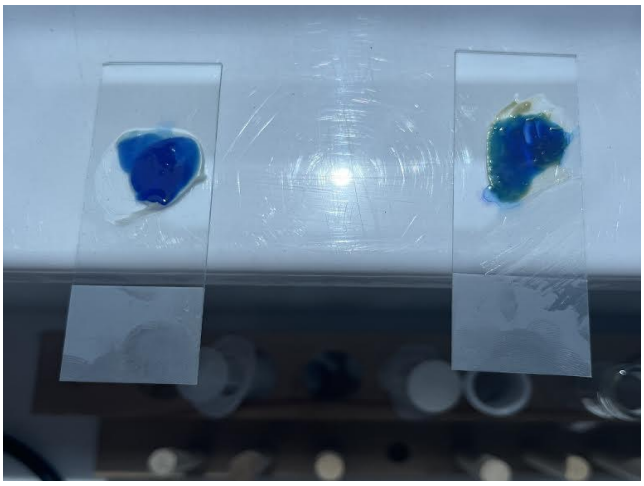
The electrical conductivity of the emulsion is that of its external phase. AO/W emulsion is more conductive than an W/O, which is much less conductive. The conductivity of the preparation

was measured at room temperature (about 25 °C) using a conductor meter and is expressed in micro-Siemens (µS/cm) (Ouatas et al., 2020).

- ✓ **By dyes**

The test is based on the diffusion of dye powder in an emulsion sample deposited on a blade. Two tests are carried out in parallel: one with a hydrophilic dye (e.g., methylene blue) and the other with a lipophile dye (ex., rouge de soudan 3). The diffusion of the dye in the respective phases of the emulsion gives the aquatic or lipophilic nature of the respective phases through an optical microscope observation (Figure II. 3).

The technique consists of taking 0.1 g of methylene blue powder with 100 ml of distilled water and putting a drop of the mixture on a quantity of the emulsion. Observing the coloration of the dispersed phase or the continuous phase allows us to determine the direction of the emulsion (picture II.8).



Picture II.8. Determination of emulsion direction by the dye method

II. 3. 4. Stability Control

II. 3. 4. 1. Centrifugal stability

This determination is used as a predictive test of emulsion stability by many authors, setting a limit of a certain number of rpm for which no instability phenomena appeared (phase shift or creaming) (Ferarsa et al, 2011).

Procedure:

- Place 20g of the prepared emulsion in a test tube;
- Place the test tube in the centrifuge for a fixed time (15 min) at 6000 rpm;
-Observe the presence or absence of creaming, sedimentation or phase shift.

II. 3. 5. Influence of air

The exposure of the formulas to air for a defined period of time allows the observation of if there is an alteration or development of molds.

II. 4. Natural emulsifier preparation

In the light of the results obtained, it was decided to prepare the natural emulsifier according to the following protocol (picture II. 9) :

- Weightsoya lecithin, potassium olivate, cetyl alcohol, and emulsifying wax
-Set the mixture on a heating plate to obtain a homogeneous mixture.
- Leave dry



Picture II. 9. Preparation of a natural emulsifier

II. 5. Application of the prepared emulsifier

The prepared emulsifier was used to prepare a moisturizing cream and a wound-healing cream. These creams were characterized microscopically and macroscopically and underwent all the tests mentioned above.

II. 5. 1 Preparation of the healing and anti-bruising cream

Table II. 12 : Phases and composition of healing cream

Phases		La composition	Pourcentage (%)
Aquous		Distilled water	QS pour 70**(%)**
		Vegetable glycerin	10**(%)**
		Xanthane gum	0.4**(%)**
		Extract	5**(%)**
Oily	Oil	Karite butter	1**(%)**
		Oily *Teucrium polium L* mecerate in lentisque oil	QS for 30**(%)**
	Emulsifier	Soy lecithine	5**(%)**
		Emulsifying wax	2.5**(%)**
		Cetyl Alcohol	2.5**(%)**
		Potassium olivate	5**(%)**

II. 5.2 Healing test

The day before applying the product to be tested, the rabbits are clipped with an electric clipper fitted with a comb with a cutting height of 0.05 mm to clear an area of around 5X5cm on the animal's back.

- During the test, the rabbits were kept in restraint boxes.
- On day D0, using a sterile needle, make three parallel scarifications on the back of each rabbit, about 2.5cm long and about 0.5cm apart.
- Apply a layer of the prepared healing cream once a day for one week.
- Observe

Chapter III

Results and discussion

III. 1.Extraction results and characterization of the ethanolic extract of *Teucrium polium L*

The extraction process for medicinal plants is a crucial step, as it determines the quality and quantity of the active ingredients sought, which directly reflect their pharmacological activities (Ben Sghaier et al., 2011). The extract prepared and collected in a shaded bottle (picture II. 1).



Picture II.1 Ethanolic extract of *Teucrium polium L*

III.2 Physico-chemical and organoleptic characterization

III.2.1 Organoleptic characteristics

The plant extract obtained is a dark green liquid brown highlights with a characteristic aromatic smell of henne .

III. 2. 2 Phytochemical screening

Qualitative phytochemical analyses were carried out on *Teucrium polium L* extract, to detect its secondary metabolites. Phytochemical tests consist in detecting the different families of compounds existing in the plant through qualitative characterization reactions. These reactions are based on precipitation or coloration by specific reagents. The results obtained are presented in Table II. 1 . The results show the presence of tannins and quinones and the absence of reducing sugars.

Table II. 1 result of phytochemical tests

Test	Color	Result
Tannins		Presence of tannins
Quinones		Presence of quinones
Reducing sugar		absence of reducing compound

III. 2. 3. Determination of total polyphenols

Total phenols were determined by spectrophotometry using the Folin-Ciocalteu reagent. The results obtained are expressed as mg gallic acid equivalent per gram of plant extract (mg EAG/gES), using the linear regression equation of the calibration curve plotted using gallic acid as the standard molecule . The result shows that *Teucrium polium* L extract contains around 83.33 mg EAG/g extract.

III. 2. 4. Flavonoid assay

Determination of flavonoids in the crude extract of *Teucrium polium* L gave a value of 111.11 mg EQ/g extract. This result corroborates that found by Elshaer et al. (2022), who found a concentration of 103.75 mg EQ/g extract. This value is a promising result for the microencapsulation of *Teucrium polium* L extract.

III. 2. 5. DPPH test

The effective sample concentration required to recover the 50% DPPH radical was obtained by linear regression analysis of the dose-response relationship between inhibition and concentration, is 8.5 µg/ml.

III.3 Results of toxicity tests

Swiss albino mice were used to evaluate the ethanolic *Teucrium polium L* extract's toxicity. The mice exhibited no alterations in behavior or indications of toxicity for the duration of the test .

III. 4. Carbonization result



Picture II. 3. Activated carbon prepared from residues of *Teucrium polium L*

III. 5. Prepared soaps' characteristics

III. 5. 1. Soft soap's organoleptic characteristics (macroscopic study)

The prepared soft soap (picture III. 4) has a light cream, shining look, an olive green color and the distinct smell of olive oil.



Picture 4: Prepared soft soap

The findings of consumer tests are displayed in table III.1 and picture III. 5.





Picture III. 5. Prepared soft soap

Consumer test results are shown in photo III.6 and table III.1.

Table III.2: Consumer test results

Try / Skin	Normal	Drying	Sensitive	fat
1	Moistrizing	-	-	-

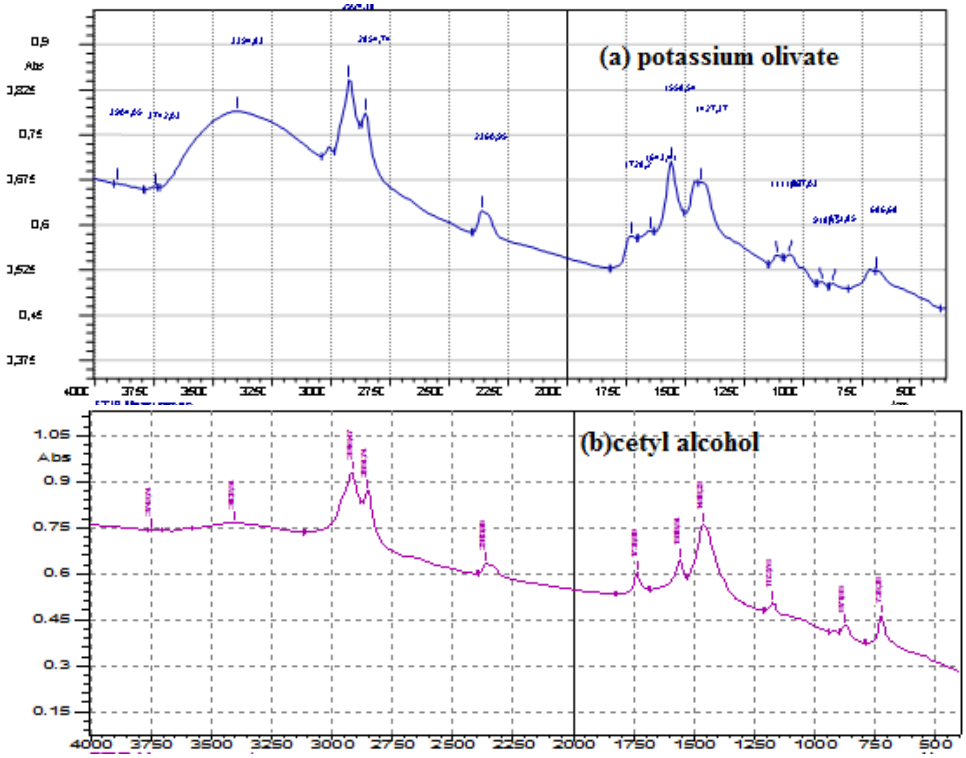
2	-	Moistrizing Brightening	-	-
3	-	-	Small Pick temporarily	-
4	-	-	-	Hydrating Brightening

III. 5. 2. Organic properties of soft solid carbon soap

This solid soap was prepared using activated charcoal made from the plant residue after extraction. The result is a black soap with an olive oil fragrance, creamy and shiny. Activated charcoal soap is recommended for graceful, acne-prone skin.

III.6. Characterization of prepared emulsifiers

Analysis by infrared spectroscopy yielded figure III. 1.



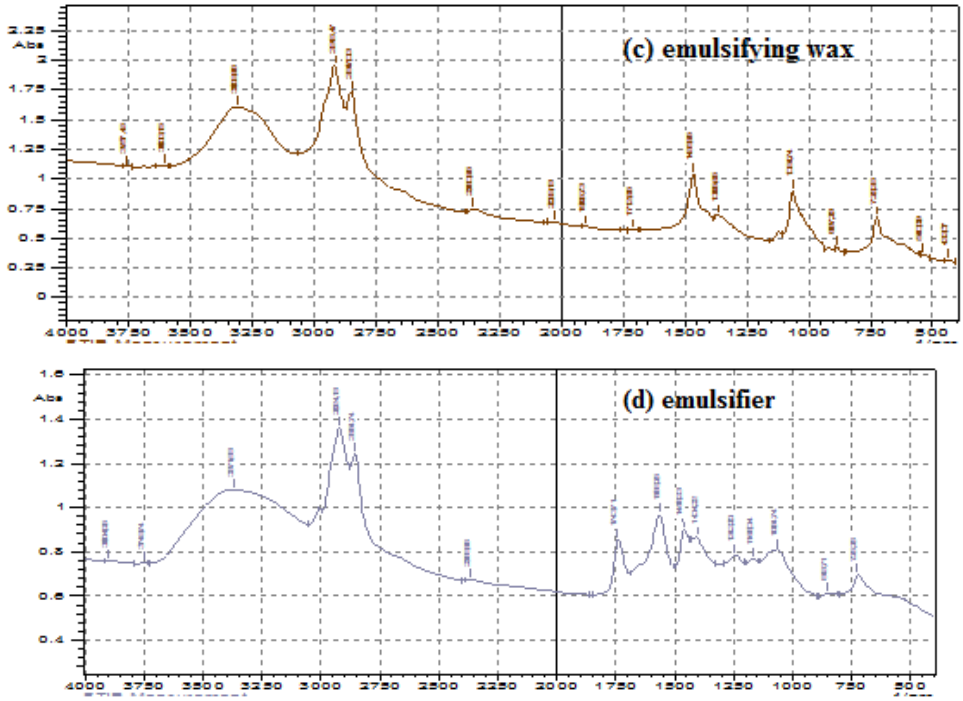


Figure III. 1. Infra-red spectrum of (a) potassium olivate (b) cetyl alcohol (c) emulsifying wax and (d) emulsifier.

The table III. 3, shows an analysis of the infrared spectra of the three constituents—potassium olivate, cetyl alcohol, and emulsifying wax—as well as the emulsifier that was produced when the combination was combined.

Table III. 3: Typical peaks of the components under analysis

	The peaks												
Emulsifying	**3371.68**	**2924,18**	**2854,74**	**2368,66**	**1743,71**	**1566,25**	**1458,23**	**1404,22**	**1242,2**	**1165,04**	**1064,74**	**848,71**	**725,26**
Potassium Olivate	+	+	+	+	+	-	+	-	-	+	+	+	-
Cetyl alcohol	+	+	+	+	+	-	+	-	-	+	-	+	+
Wax L'émulsifiant	+	+	+	+	-	-	+	-	-	-	+	+	+

Realizing that

- The characteristic band of the OH function at 33371.68cm-1 corresponds to bonded O-H (H bond): broad band at [3500-2800] (Figure III. 1).
- The characteristic bands of the carboxylic CH function at 2924.18cm-1 and 2854.74 cm-1: [2500-3200]).
- The characteristic band of the CO (ester) and carboxylic function at 1743.71cm-1and 1566.25cm-1 , respectively present in soaps (fatty acid ester): band present in the spectrum of potassium olivate and cetyl alcohol.
- The characteristic band of the CO function at 1458.23cm-1 and 1404.22cm-1carboxylic is present in primary alcohols (O-H (primary alcohol): [1350-1260]).
- The elongation band characteristic of the C-H bond . The band at 1242.2cm-1 and 1165.04cm-1 may also be the deformation band corresponding to the C-H bond (C-H of aliphatic chains and CH3 groups: [3000-2700] and [1404-1249]).
- The band of the long-chain -C-H2 bond at 725.26cm-1.

The spectrum shows 4 peaks 3371.68cm-1, 2924.18cm-1, 2854.74cm-1 and 2368.66cm-1 in all four spectra, confirming that the three compounds have been mixed.

We also note the appearance of two new peaks (1404.22 cm-1 and 1242.2 cm-1)
in the infrared spectrum of the emulsifier.

III.7. Characterization of the resulting emulsions

III.7. 1. Quality control of formulated creams

Cosmetic product stability is one of the key parameters for guaranteeing product quality and consumer satisfaction. The wide variety of product forms in this field (milk, cream, mousse, etc.), the diversity of usage properties and storage conditions make stability testing long and tedious. What's more, the large number of components in these products means that the data obtained by conventional analytical techniques is difficult to interpret. The results of the mecanical stability of emulsions are presented in table III. 4.

Table III. 4. The experimental matrix showing the different compositions of the emulsions and stability test results

Experience	Soy Lecithin	Emulsifying wax	Cetyl alcohol	Karite Butter	Potassium Olivate	Xanthan gum	stabilité	L'aspect
1	+	+	+	-	+	+	+	cream
2	-	+	+	+	+	-	±	Lotion
3	-	-	-	+	+	+	-	
4	+	-	-	-	+	+	-	
5	-	+	+	-	-	+	+	cream
6	+	-	-	+	-	-	-	
7	+	+	+	-	+	-	±	Lotion
8	-	-	-	-	-	-	-	
9	0	0	0	0	0	0	±	Lotion

- Unstable, + stable, ± slight stability

Study of the influence of each component on emulsion stability. The first series studied the stability of formulas 1 and 5 without xanthan gum and without emulsifying wax. The results obtained are presented in Table III. 5.

Table III. 5: Stability study results for F1, F5 and F9 without xanthan gum and emulsifying wax

	Without Xanthan gum and Emulsifying wax		
	F1	**F5**	**F9**
Color	Beige	Beige	Unstable
Smell	Olive oil	Olive oil	
appearance	Light fluid cream, glossy soft to the touch	Lotion – brilliant	
Application	Soft and moist, its stretching does not take much time and the skin absorbs it easily		
After application	a rather light texture with a good feeling of fresh hydration immediately after spreading on the skin		

Table III. 5, shows that both formulas remain stable with fluid cream, except that formula 5 produces fluid milk. Formula 9 became unstable.

In the second series of experiments, we chose to repeat formulas F1, F5 and F9 without the emulsifying wax, but with the addition of xanthan gum. The results obtained are shown in Table III. 6.

Table III. 6: Stability study results for F1, F5 and F9 without emulsifying wax and with xanthan gum

	With Xanthan gum and without Emulsifying wax		
	F1	**F5**	**F9**
Color	**Beige**	**Beige**	**beige**
Smell	**Olivate oil**	**Olivate oil**	**Olivate oil**
Appearance	**Light fluid cream to lotion , glossy soft to the touch**	**Light fluid cream, glossy soft to the touch**	**Lotion – brilliant**
Application	**Soft and moist, its stretching does not take much time and the skin absorbs it easily**		
After application	**Soft texture that leaves a good feeling of hydration and freshness.**		

The addition of xanthan gum slightly thickened the emulsion obtained with formula N°5, resulting in a fluid cream. The emulsion obtained with formula N°9, on the other hand, regained its stability and produced a milk-like consistency.

The positive effect of xanthan gum is due to the fact that it is water-soluble and is used in the preparation of emulsions. Under appropriate conditions of concentration, it is used to prevent the flocculation and creaming of emulsions, due to the increase in the apparent viscosity of the continuous phase, which retards the movement of dispersed droplets. And thanks to its unique rheological and thickening properties, xanthan gum is recognized as an excellent emulsion stabilizer. It is also recognized for its very high stability under different pH and temperature conditions in addition to being soluble both hot and cold (Benmeziane, 2013).

Similarly, cetyl alcohol is used as a co-emulsifier and consistency agent to stabilize emulsions and modulate their texture. It thickens creams and adds a creamy, nourishing feel, which explains its positive effect on emulsion stability.

The results of the effect of adding emulsifying wax to formulas 1 and 5 yielded the results shown in Table III. 6**.**

Table III. 7: Stability and appearance of F1, F5 with the addition of emulsifying wax

	With Emulsifying wax	
	F1	**F5**
color	**Beige**	**Beige**
smell	**Olivate oil**	**Olivate oil**
appearance	**Thick cream , glossy to the touch soft and silky**	**Thick cream , glossy to the touch soft and silky**
application	**Soft texture that penetrates quickly through the skin.**	
After application	**Soft texture that leaves a good feeling of hydration and freshness.**	

Table III. 7, shows that formulas F1 and F5 give consistent creams. This shows that the emulsifying wax acts as a thickener.

The effect of potassium olivate on the stability and appearance of the emulsion obtained by formula 1 was also studied (Table III. 8).

Table III. 8. Series of experiments carried out without potassium olivate and Emulsifying wax

Formule	**Soy Lecithin**	**Cethyl alcohol**	**Xanthan gum**	**stabilité**
1	**+**	**+**	**+**	**unstable**

As showns in the Table III. 8, in the absence of Potassium olivate we obtained unstable emulsion due to its role in stabilizing the emulsion. So the addition of small quantities of potassium olivate enabled us to obtain a stable emulsion (table III. 9).

Table III. 9. Series of experiments carried out with Emulsifying wax

experience	Soy Lecithin	Emulsifying wax	Cethyl alcohol	Potassium Olivate	Xanthan gum	stabilité
5	-	+	+	-	+	**stable**

The appearance of the emulsion obtained with modified formula N°5 is shown in Table III.10.

Table III. 10. Appearance of formula N°5 emulsion

	with emulsifying wax and xanthane gum
Color	**Beige**
Smell	**Olivate oil**
Aspect	**Thick cream , glossy to the touch soft and silky**
Application	**Soft texture that penetrates quickly through the skin.**
After application	**Soft texture that leaves a good feeling of hydration and freshness.**

The elimination of acetyl alcohol from formulas N° 1 and N° 5 rendered both emulsions unstable whatever their composition (Table III. 11). This leads us to conclude that cetyl alcohol plays an important role in emulsion stabilization under the conditions of our work and is an important component in the emulsifier prepared.

Table III. 11. Series of experiments carried out without cetyl alcohol

experience	Soya Lecithin	Emulsifying wax	Potassium Olivate	Xanthan gum	stabilité
1	+	+	+	+	**unstable**
2	-	+	-	+	**unstable**

The macroscopic examination of various stable formulas demonstrates that the ingredient selection was successful; all formulas are light to thick and have a soft, moist texture that leaves a sense of freshness, confirming the richness of these ingredients, such as oils, karité butter, and the emulsifier used. Their colors and fragrances are directly tied to the ingredients, and the nature and quantity of these substances determine the formula's overall texture and shape.

III.7.2. Physicochemical characterization of prepared emulsions

III. 7. 2. 1. Determination of pH

Each manufactured emulsion's pH must be checked to establish its acidity, neutrality, or basicity, which can have implications for both technology and therapy. It may also have an effect on the physical stability of the emulsion. Figure III. 2 represent the pH measurement findings for various stable emulsions.

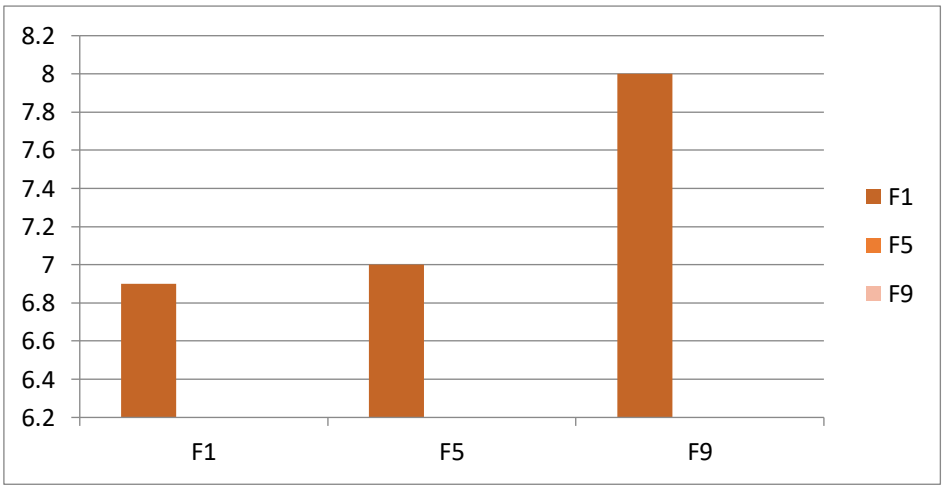


Figure III. 2. Graphical presentation of pH values of stable formulas



Picture III. 6. Different pH for stabilized formula

Picture III.6 indicates that the resulting emulsions have a baseline pH range from 7 to 8. It is slightly alkaline compared skin pH and must be adjusted to a pH suitable for the skin, which is between 5.5 and 6.The pH was adjusted by adding citric acid (2%) drop by drop, while rapidly swirling and measuring.



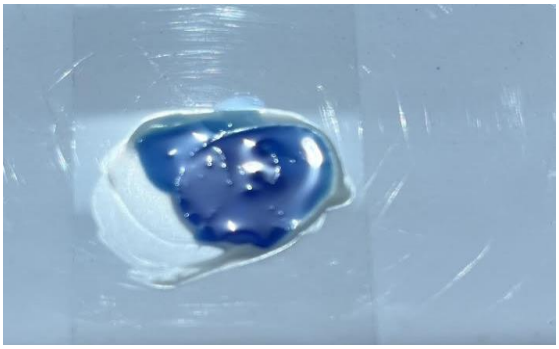
Photo III. 7: Changes in the texture of formula (a) before adjustment of pH (b and c) after pH adjustment.

After adding lactic acid (2%) drop by drop we noticed changes in the texture of the emulsion , which became more thick and more creamy .

III.7.2.2. Determination of the sense of the emulsion

- By coloring

A solubilisation of methylene blue is observed throughout the sample (photo III. 8), so this confirms that the emulsions prepared in our work are w/o type.



Picture III. 8 : Methylene blue test

III. 7. 2. 4. Influence of air

After exposing the various stable formulae to air for 15 days at room temperature, it is noted that formula 9 had changes as a phase-out and development of the mold, but formula 1 and formula 5 did not have any modification or development of mold.

We concluded that the formulas (5) and (1) are well resistant to mechanical action, as well as to oxidation and mold development .

III.8. characterization of formula with prepared emulsifier ;

In this part of the work, we prepared an emulsifier by mixing all the ingredients we have according to the matrix presented in Table III. 11. The emulsifier obtained is shown in Figure III. 9.

Table III. 11.table of prepared emulsifier

	Soya Lecithin	**Emulsifying wax**	**Cethyl alcohol**	**Potassium Olivate**	**Stabilization**	**The quantity of the mixture**
Emulsifier1	+	-	-	+	Stable	13.3g
Emulsifier 2	-	-	-	-	Stable	10g



Picture III. 9. Preparation of a natural emulsifier

III. 9. Application of the prepared emulsifier

III. 9. 1. Healing cream

To obtain a good texture cream we prepares an emulsion using ingredients of formule N°1 :

Table III. 12 : formulation of the healing cream

Cream	**Healing cream**
Ingridients	**Emulsifier 1**
	Karite butter
	Oily *Teucrium polium L* mecerate in lentisque oil
	Extract
	Xanthan gum
	Vegetable glycerin
	Distilled water

III. 9. 1. 1.Organoleptic properties

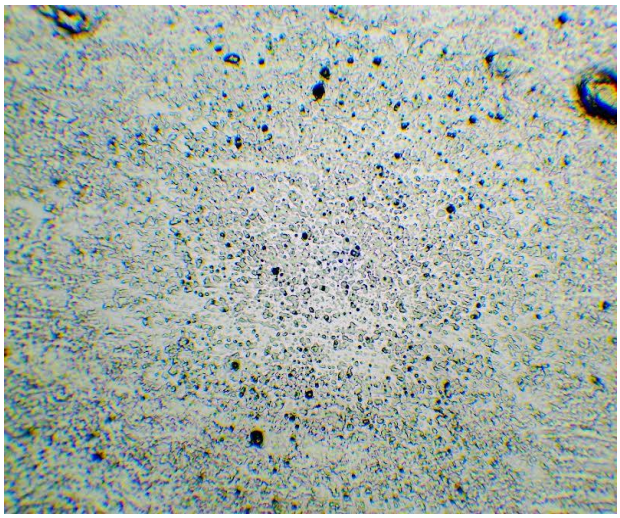
The macroscopic observation of emulsions is one of the user acceptability tests. The examination is done with the naked eye directly on the formulated emulsions. The main characteristics observed are: color, smell, physical aspects, consistency and homogeneity of the preparation (Moussaoui et al, 2004) (Table III. 13).

Table III. 13 Macroscopic examination of healing cream

	Healing cream
Color	Olive color
Smell	The smell of lentisk oil
appearance	Thick cream , glossy to the touch soft and silky
application	The cream is light on the skin, easy to apply and moisturizes the skin.
After application	After a few days, the skin is healed and moisturized.

III. 9. 1. 2. Microscopic observation of the prepared healing cream

Microscopic observation of the prepared healing cream produced the result shown in picture III.10.



Picture III. 10. Microscopic observation of healing cream

Picture III. 10, shows that the emulsion is homogeneous and that the micelles formed are small and well distributed throughout the emulsion. After preparation, the cream has a neutral pH of around 7. After adjustment by adding lactic acid (2%), drop by drop, while rapidly swirling and measuring, the pH becomes 6.19, which is compatible with the pH of the skin.

III. 9. 1. 3. The stability

- ✓ **Centrifugation**

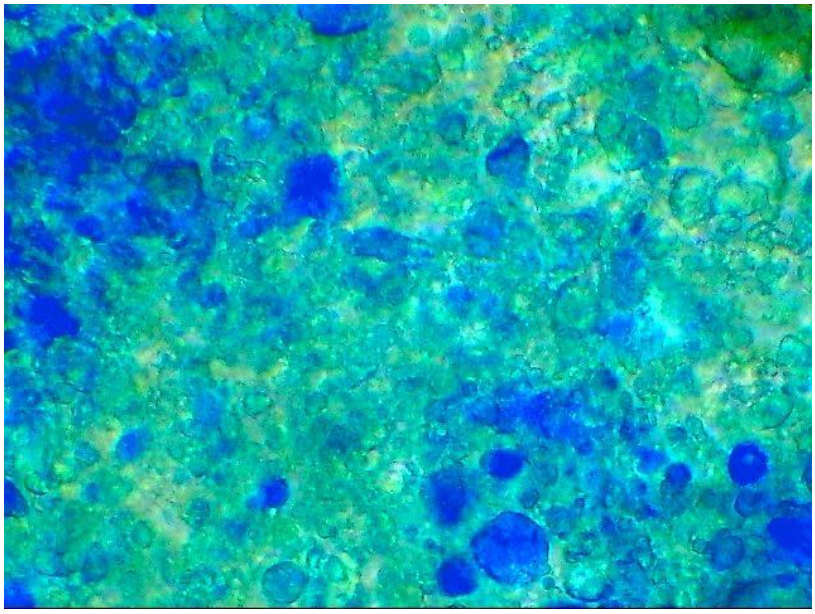


Picture III.11. centrifugation of healing cream

We can see that there is no separation between oily and aqueous phases which confirms that our emulsion is stable.

III. 9. 1. 4. Emulsion direction analysis by dye method (methylene blue):

Shows that the water-soluble dye remains on the emulsion surface and does not penetrate. This indicates that the dispersed phase is oily and the continuous phase is water, so the emulsion is of the O/W type. This result is confirmed by my conductivity measurement, which yielded a value of 860 µS/cm.



Picture III.12. Microscopic observation of sense of healing cream

General conclusion

Emulsions are widely used systems in various fields, but their development is limited by their instability, which is linked to their ingredients and mainly to the emulsifier. The aim of this work is to prepar a natural emulsifier using raw materials of algerian origin. And to use it to prepare a healing cream based on the plant's ethanolic extract.

In the first stage, the ethanolic extract of *Teucrium polium* L. was prepared. Phytochemical screening showed that it contains quinons, tannins and no reducing compounds. It contains 83,33mg EAG/g d'E en total polyphenols, 111,11 EQ/g d'E of falvonoides. The ddpH test showed that IC50% is 8,28µg/ml.

As part of the circular economy, the plant biomass recovered after extraction was used to prepare activated carbon, which in turn was used to prepare a soft soap (Dzair soap). The toxicity test showed that *Teucrium pollium* L extract was not toxic at a dose of 800mg/kg.

In the second stage of our work, we prepared :

- Potassium olivate surfactant
- Emulsifying wax

These two molecules were used in combination with cetyl alcohol to prepare various emulsions by hot emulsification using the experimental design method. The stability study showed that :

- Formulas F1 F5 are stable
- Formulas F2 F9 and F7 gave slightly stable emulsions. A study of the influence of each component on emulsion stability showed that:
- Xanthan gum makes emulsions more stable
- Emulsifying wax makes the cream smooth and consistent, acting as a thickener
- Potassium olivate acts as a co-emulsifier, helping to stabilize the emulsion and adds a olive oil sweetness to the emulsion formed
- Cetyl alcohol is essential for emulsion stability

These components are used not only as emulsifiers, but also to give the cream its skin replenishing, moisturizing and nourishing properties.

The physicochemical characterization of the emulsions prepared enabled us to obtain the following results:

1) Determination of pH: all the emulsions obtained have a basic pH ranging from 7 to 8. Adjusting the pH to the appropriate pH for skin 5.5- 6 resulted in :

formula F1 and F5 lowering pH improved emulsion appearance

2) Direction of emulsion is O/W

- The results of the water-soluble dye test showed that methylene blue is not soluble in formulas 1 and 5.

- Conductivity 860 µS/cm for emulsions N°1

In the third step, we prepared a natural emulsifier by mixing the three ingredients: potassium olivate, emulsifying wax and cetyl alcohol. Infrared spectroscopy showed that the mixture was well blended, with characteristic peaks of the three components appearing in addition to new peaks. The final emulsifier formula is 5g soy lecithin, 2.5g cetyl alcohol, 2.5g emulsifying wax and 5g potassium olivate, giving us a homogeneous emulsifier with a yellow-orange color and a pasty texture.

In the fourth step, we prepared a healing cream based on the ethanolic extract of the *Teucrium pollium* L plant, using the prepared emulsifier (the mixture) to obtain a beautiful cream.

A thick cream with an olive-green color, very moisturizing due to the mixture of these ingredients, has a pH of 5.56 after adjustment with cetric acid, tastes like lentisque oil, finally after testing we find that it has an O/W direction.

In fiveth step , we did the test of healing and anti-burn on rabbits and we noticed that our cream has an efficacy yield

We propose to :

- Better characterize these emulsifiers by means of an examination using a technique that will enable us to determine the CMC;
- Carry out microbiological and rheological tests on the prepared cream to develop and better characterize it.

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