Ministry of Higher Education and Scientific Research

University Kasdi Merbah Ouargla

Faculty of Mathematics and Materials Science

Department of Chemistry

Thesis submitted in partial fulfillment of the requirements for obtaining an Academic Master's degree in Chemistry

.

Specialization:

Materials Chemistry

Prepared by:

Boulifa Oumessad Manar

Khettta Doha

Entitled:

Exfoliating creams preparation from natural active-comparative study between different creams

Defended publicly on 15/06/2026

Before the Examining Committee

Saidat Moustrapha	Professor at University of Ouargla	Discussing
Benmnin Abdelkader	Professor at University of Ouargla	President
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الإهداء

.رسمتُ اليوم حروفي بفخرٍ كبير، وفي قلبي يزهر فرح نجاحي الذي طالما حلمتُ به

رغم كل العثرات والصعاب، وبفضل الله أولًا، ثم بالصبر والإصرار، ها أنا أخطو أولى خطوات حلم طال انتظاره. هذا التخرج ليس مجرد ورقة، بل قصة كفاح وشهادة انتصار لكل من حاول أن يثنيني عن الوصول، وبكل حب وفخر أهدي ثمرة جهدي وتخرجي هذا إلى

.لمن صبرت وثابرت، لمن آمنت بالحلم وسعت إليه حتى أصبح واقعًا مشرقًا

لقلبي النابض ونبض روحي، أعظم نعم ربي... أمي الغالية **(بوقنينة حسينة)**

إليكِ يا من كنتِ لي وطنًا وسندًا ونورًا لا يخبو بعطفك وحنانك، بلغت هذا الحلم بفضل الله ثم بفضلك. شكرًا لكِ على كل تضحية، وعلى كل دعوة رفعتها يداكِ لأجلي. أسأل الله أن يحفظكِ ويديم عليكِ الصحة والعافية ويجزيكِ .عني خير الجزاء

إلى ذلك الرجل العظيم، السند الأول في حياتي، أبي العزيز **(صالح بوليفة)**

كنتَ دائمًا مصدر قوتي وأماني، وغرست في نفسي الثقة والإصرار على النجاح. لك مني كل الشكر والامتنان، .وأسأل الله أن يبارك في عمرك ويحفظك ويجعلني دائمًا سببًا لفخرك

"من قيل فيهم: "سنشد عضدك بأخيك

إلى أخي العزيز **(محمد فائز حرز الله)**، رفيق الدرب وسند الأيام، شكرًا لكل لحظة دعم ومساندة وتشجيع، أسأل .الله أن يوفقك ويحقق لك كل ما تتمنى

إلى أختي الغالية **(حنين)**

إلى من كانت قريبة من قلبي دائمًا، تشاركني أفراحي وأحزاني، وتقف بجانبي كلما احتجت إليها، حفظكِ الله .وأسعدكِ ووفقكِ في حياتك

إلى رفيقات دربي وصديقاتي

من شاركني لحظات التعب والاجتهاد والنجاح، ومن كن خير سند خلال سنوات الدراسة، إلى كل صديقاتي دون .استثناء، لكن مني كل المحبة والتقدير

إلى عائلتي الكريمة

.التي كانت ولا تزال مصدر الأمان والقوة، والتي أحاطتني بالدعم والمحبة في كل مراحل حياتي

إلى الراحلين الباقين في الذاكرة والروح

.سلامٌ على أرواحكم الطاهرة، رحمكم الله رحمة واسعة وأسكنكم فسيح جناته

إلى أساتذتي الأفاضل

الذين غرسوا فينا حب العلم والمعرفة، وكان لهم الفضل في توجيهنا وإرشادنا طوال مسيرتنا الجامعية، لكم مني خالص الشكر والامتنان

ام السعد منار

الإهداء

...إلى نفسي

إلى تلك الفتاة التي حلمت كثيرًا، وسعت أكثر، وتحملت التعب والقلق والضغوط حتى بلغت هذه اللحظة، أهدي هذا الإنجاز الذي لم يكن سهل المنال، والذي كان ثمرة الصبر والاجتهاد والإيمان بالله.

...إلى أبي العزيز

إلى الرجل الذي كان وما يزال مصدر قوتي وفخري، إلى من علمني أن الطموح لا حدود له وأن النجاح يحتاج إلى عزيمة وإصرار، أهديك هذا العمل تقديرًا لكل ما قدمته من تضحيات من أجلي.

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... إلى إخوتي

أنتم أجمل سند وأقرب رفاق، شاركتموني أفراحي وأحزاني، وكنتم دائمًا مصدر دعم وتشجيع، فلكم مني كل المحبة والامتنان.

...إلى عائلتي الكريمة

الذين أحاطوني بالمودة والدعم، وكانوا دائمًا مصدر فخر واعتزاز، أهديكم ثمرة هذا الجهد المتواضع.

...إلى أصدقائي وصديقاتي

الذين رافقوني خلال هذه الرحلة الطويلة، وشاركوا معي لحظات التعب والنجاح، شكرًا لكم على كل لحظة جميلة وكل كلمة تشجيع.

وإلى كل من علمني حرفًا، وإلى كل من ساهم في دعمي ومساندتي من قريب أو بعيد، أهدي هذا العمل المتواضع، راجيةً أن يكون بدايةً لنجاحات أكبر في المستقبل.

ضحى

شكر والعرفان

بسم الله الرحمن الرحيم، والحمد لله الذي بنعمته تتم الصالحات، والذي وفقنا وأعانناعلى إتمام هذا العمل.

نتقدم بأسمى عبارات الشكر والتقدير والاحترام إلى الأستاذين **موساوي ياسين** و**حساني عبد القادر** الذي لم يبخلا علیّنا بالنصح والتوجيه والمتابعة طوال فترة إنجاز هذه المذكرة، فلهما منا جزيل الشكر وعظيم الامتنان.

كما أتوجه بخالص الشكر إلى أعضاء لجنة المناقشة المحترمين على قبولهم مناقشة هذا العمل، وعلى ما سيقدمونه من ملاحظات وتوجيهات قيمة تسهم في تطويره.

ونتقدم بالشكر إلى جميع أساتذة قسم الكيمياء بجامعة جامعة قاصدي مرباح ورقلة، الذين كان لهم الفضل في تكويننا العلمي والمعرفي طوال سنوات الدراسة.

ونخص بالشكر والامتنان عائلتنا الكريمة، اللذين كانا مصدر الدعم والقوة والأمل، وأدين لهما بكل ما وصلنا إليه من نجاح، وإخوتنا على تشجيعهم ومساندتهم الدائمة.

كما نشكر أصدقائنا وزملائنا الذين رافقوننا خلال هذه المسيرة، وقدموا لي الدعم والمساعدة في مختلف مراحل إنجاز هذا العمل.

وفي الختام، نتقدم بالشكر إلى كل من ساهم من قريب أو بعيد في إنجاز هذه المذكرة، سائلاً الله تعالى أن يجزي الجميع خير الجزاء.

والله ولي التوفيق.

List of Abbreviations and Symbols

Abbreviation / Symbol	Meaning
O/W	Oil-in-Water
W/O	Water-in-Oil
PH	Potential of Hydrogen
SEM	Scanning Electron Microscope
EDS	Energy-Dispersive X-ray Spectroscopy
EDTA	Ethylenediaminetetraacetic acid
AHA	Alpha-Hydroxy Acids
BHA	Beta-Hydroxy Acids
PHA	Polyhydroxy Acids
ROS	Reactive Oxygen Species
SCG	Spent Coffee Grounds
UV	Ultraviolet
FDA	Food and Drug Administration
MoCRA	Modernization of Cosmetics Regulation Act
EC	European Commission
Rpm	Rotation per minute
Pa.s	Pascal-second
mPa.s	Millipascal-second
Cm	Centimeter
Mm	Micrometer
G	Gram
%	Percent
°C	Degree Celsius

H	Hour
Min	Minute
F1	Formulation 1 (Coffee 8%)
F2	Formulation 2 (Rice 8%)
F3	Formulation 3 (Jojoba 8%)
F4	Formulation 4 (Mixture: Coffee 4% + Rice 4%

List of Tables

List of Figures

General Introduction

Background of study

The skin is a vital organ that serves as the body's primary barrier against various environmental threats, such as pollution, microbes, and ultraviolet (UV) radiation. Over time, persistent exposure to these external stressors can significantly compromise skin health and lead to long-term damage. (Baker et al., 2023)

The accumulation of dead keratinocytes on the skin's surface, triggered by these external factors, often leads to a dull complexion, irregular texture, and congested pores. This progression adversely affects the skin's overall aesthetic and health. Consequently, adhering to a structured skincare regimen is essential for maintaining a healthy and clear cutaneous surface. (Ehrhardt Proksch et al., 2020)

Exfoliation remains a cornerstone of dermatological maintenance, primarily due to its role in facilitating the shedding of dead corneocytes and stimulating cellular regeneration. This process is essential not only for refining skin texture and enhancing radiance but also for optimizing the percutaneous absorption of active pharmacological agents found in various cosmetic formulations. (Shinde et al., 2023)

The cosmetic industry has recently undergone a significant shift toward the integration of organic and plant-based components. Modern consumers increasingly prioritize bio-based formulations, perceiving them as safer, more biocompatible, and environmentally sustainable alternatives to their synthetic counterparts. (Gaivão, 2023)

Consequently, contemporary research has pivoted towards the strategic development of cosmetic formulations derived from botanical matrices and bioactive secondary metabolites. These natural constituents exhibit significant therapeutic efficacy, particularly through their potent antioxidant properties, which are essential for the neutralization of reactive oxygen species (ROS) and the overall enhancement of dermal homeostasis. (Rahmani et al., 2024)

Natural ingredients are characterized by a rich profile of bioactive constituents, specifically essential vitamins, polyphenols, and fatty acids. These compounds exert a multi-functional effect on the integumentary system by reinforcing the dermal barrier, mitigating pro-inflammatory responses, and optimizing transepidermal hydration. (Barrajón-Catalán, 2020)

Coffee is widely utilized as a natural exfoliating agent due to its inherent granular morphology, which facilitates the mechanical removal of desquamated corneocytes and accumulated impurities from the epidermal surface. Furthermore, coffee is characterized by a rich profile of bioactive constituents, notably caffeine and polyphenols. These compounds exhibit potent antioxidant efficacy, which plays a critical role in neutralizing free radicals, thereby enhancing dermal integrity and improving the overall aesthetic appearance of the skin. (Mendes dos Santos et al., 2021)

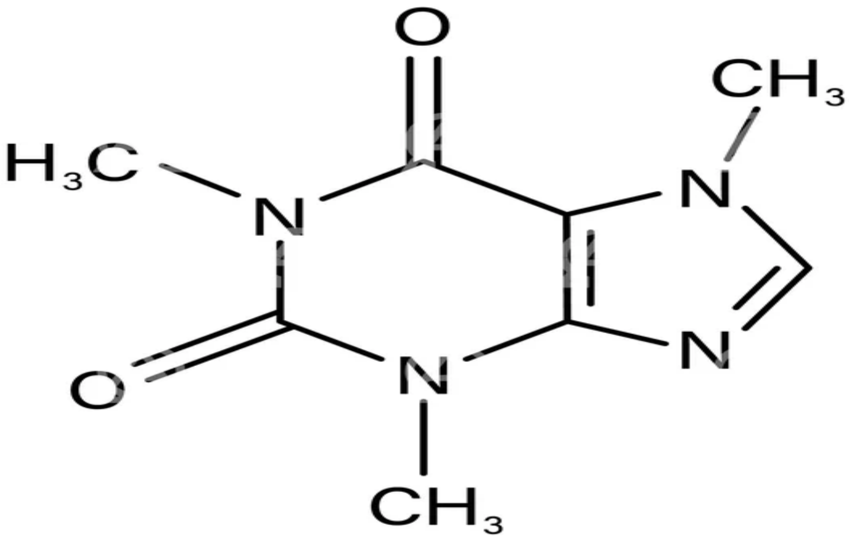

Figure 1: chemical structure of Caffeine

Rice derivatives are extensively incorporated into dermatological formulations, where rice powder functions as a mild mechanical exfoliant. It facilitates the removal of desquamated cells without inducing dermal irritation or compromising the epidermal barrier. Furthermore, rice is a rich source of bioactive nutrients and antioxidants, notably ferulic acid and phytic acid, which are recognized for their potential in melanogenesis inhibition (skin brightening) and the refinement of cutaneous texture. (Beldieva, 2023)

Jojoba is a prominent botanical substrate derived from the seeds of the Simmondsia chinensis plant. It is characterized by a complex profile of bioactive lipid constituents that are highly compatible with human sebum. In addition to its liquid wax esters, the ground seeds of jojoba are utilized as a natural mechanical exfoliant, providing a gentle yet effective method for removing epidermal debris without disrupting the lipid mantle of the skin. (Gad et al., 2021)

Ground jojoba seeds provide a mild exfoliating effect owing to their inherent granular morphology, which facilitates a non-abrasive mechanical action. In addition to their resurfacing properties, these botanical particles contribute to the enhancement of dermal integrity and the reinforcement of the skin's protective barrier. Consequently, jojoba derivatives are highly suitable for incorporation into natural exfoliating formulations, offering a synergistic balance between effective desquamation and epidermal protection.

In general, cosmetic creams are formulated as multiphase emulsions, typically consisting of an aqueous phase and an oil phase. These delivery systems are extensively utilized due to their superior spreadability and their versatile capacity to encapsulate and stabilize diverse bioactive ingredients, ensuring effective dermal delivery. (Katya Hutova, 2025)

Physicochemical attributes, specifically dynamic viscosity and thermodynamic stability, are critical determinants of a formulation's quality and therapeutic efficacy. Consequently, a comprehensive rheological evaluation and stability testing are mandatory during the development of any cosmetic product to ensure structural integrity and consistent performance throughout its shelf life. (Hutova et al., 2025)

Building upon the aforementioned theoretical framework, the present study aims to formulate natural exfoliating creams incorporating coffee, rice, and jojoba seeds as active abrasive agents. Furthermore, a comparative analysis will be conducted across the different formulations to evaluate their physicochemical stability, rheological properties, and overall dermatological efficacy in skin maintenance. (Dighe et al., 2025)

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Problem Statement

The cosmetics industry has experienced significant growth in recent years, driven by increasing consumer demand for skincare products that are safe, effective, and environmentally friendly. Most conventional exfoliating creams rely on microplastic beads or chemical substances that may cause skin irritation or contribute to environmental pollution. This has prompted researchers to explore safer natural alternatives for both human health and the environment.

Among the most promising natural alternatives are coffee powder, rice powder, and jojoba seeds, which are derived from plant sources or agricultural by-products. These ingredients possess antioxidant and anti-inflammatory properties and can gently exfoliate dead skin cells, promote skin renewal, and improve skin texture while reducing potential risks compared with synthetic ingredients.

In addition, the reuse of agricultural residues such as coffee grounds and rice bran contributes not only to exfoliation purposes but also to the promotion of environmental sustainability. Despite the growing interest in these natural materials, there is still a lack of comprehensive comparative studies evaluating their stability, effectiveness, and cosmetic characteristics.

Therefore, this study focuses on the preparation of exfoliating creams using different natural ingredients and comparing them to determine the most stable and effective formulation for skin application.

Research Objectives

- This study aims to formulate exfoliating creams based on natural ingredients such as coffee grounds, rice powder, and jojoba beads, due to their well-known effectiveness in cosmetic applications. (Mendes dos Santos et al., 2021)

- A fourth formulation containing a mixture of coffee grounds and rice powder (4% each) will be prepared to study the synergistic effect between these natural exfoliating agents

- After formulation, the creams will be evaluated in terms of their physicochemical properties, including color, texture, viscosity, pH, and spreadability, as these factors play a crucial role in the quality of the final product.

- The study also focuses on assessing the stability of these creams under different temperature and storage conditions to determine their stability over time.

- The effectiveness of the different cream formulations will be compared in terms of their ability to remove dead skin cells and improve skin texture.

- The research aims to identify the best natural formulation in terms of effectiveness, stability, and desirable cosmetic properties for cosmetic use.

Reference

1. Baker, P., Huang, C., Radi, R., Moll, S. B., Jules, E., & Arbiser, J. L. (2023). Skin barrier function: The interplay of physical, chemical, and immunologic properties. *Cells*, 12(23), 2745. https://doi.org/10.3390/cells12232745
2. Dighe, S. S., Sangale, S. S., Magar, M. M., & Aher, N. B. (2025). Formulation and evaluation of herbal cold cream. *International Journal for Research in Applied Science & Engineering Technology (IJRASET),* 13(5), 6273–6284. https://doi.org/10.22214/ijraset.2025.71651
3. Gad, H. A., Roberts, A., Hamzi, S. H., Touiss, I., Altyar, A. E., Kensara, O. A., & Ashour, M. L. (2021). Jojoba oil: An updated comprehensive review on chemistry, pharmaceutical uses, and toxicity. *Polymers,* 13(11), Article 1711. https://doi.org/10.3390/polym13111711
4. Gonçalves, S., & Gaivão, I. (2023). Natural ingredients in skincare: A scoping review of efficacy and benefits. *Biomedical and Biopharmaceutical Research,* 20(2), 143–160. https://doi.org/10.19277/bbr.20.2.328
5. Herranz-López, M., & Barrajón-Catalán, E. (2020). Antioxidants and skin protection. *Antioxidants,* 9(8), Article 704. https://doi.org/10.3390/antiox9080704
6. Hutova, K., Andonova, V., Panova, N., Ivanov, I., Nikolova, K., & Gugleva, V. (2025). Design and characterization of cosmetic creams based on natural oils from the Rosaceae family. *Cosmetics,* 12(6), Article 248. https://doi.org/10.3390/cosmetics12060248
7. Marathe, V. S., & Nikum, A. P. (2023). Formulation and evaluation of herbal face scrub. *International Journal for Research in Applied Science and Engineering Technology (IJRASET),* 11(4), 2261–2266. https://www.ijraset.com/research-paper/evaluation-of-herbal-face-scrub
8. Proksch, E., Berardesca, E., Misery, L., Engblom, J., & Bouwstra, J. (2020). Dry skin management: Practical approach in light of latest research on skin structure and function. *Journal of Dermatological Treatment,* 31(7), 716–722. https://doi.org/10.1080/09546634.2019.1607024

9. Rahmani, A., Tabchouche, A., Hassani, A., Zoubeidi, N., Zerrouki, D., & Djafer, L. (2024). Effect of Chlorella pyrenoidosa microalgae extract and powder mixture on skin rejuvenation and antioxidant enhancement in the formulation and evaluation of a facial peeling cream with natural ingredients. *African Journal of Biological Sciences,* 6(14), 5206–5318. https://doi.org/10.48047/AFJBS.6.14.2024.5206-5318

10. Santos, É. M. de, Macedo, L. M. de, Tundisi, L. L., Ataide, J. A., Camargo, G. A., Alves, R. C., Oliveira, M. B. P. P., & Mazzola, P. G. (2021). Coffee by-products in topical formulations: A review. *Trends in Food Science & Technology,* 111, 280–291. https://doi.org/10.1016/j.tifs.2021.02.064

11. Tarasov, V., & Beldieva, N. (2023). Rice screenings as effective ingredients in beauty products. *E3S Web of Conferences,* 389, Article 03027. https://doi.org/10.1051/e3sconf/202338903027

Chapter I

General Introduction and Literature Review

I .1. Introduction

The skin, being the largest organ in the body, is the most comprehensive interface between internal and external environments. Therefore, it has two main functions: it is a reflection of a person's general health status, and it is a primary physical barrier against external aggressors. several cosmetic products and skin treatments have been developed over the centuries to improve skin appearance.

Exfoliation is one of these practices that has become a necessary part of skincare routines. During this process, the stratum corneum, which is the outermost layer of the skin, is cleared of all dead cells. There is a natural desquamation process that occurs in skin, resulting in the shedding of corneocytes. However, this normal physiological process disrupted with by factors such as aging, pollution, and lifestyle, resulting in the accumulation of dead cells. This can cause a variety of skin problems, including uneven texture and acne. for this reason, that exfoliation is considered necessary for maintaining healthy skin.

Exfoliating products are readily available in the cosmetics market and can be classified into two main types. the intercellular bonds holding dead cells together are dissolved with chemical exfoliants that contain acids or enzymes. Physical exfoliants, on the other hand, work by using abrasive particles to remove dead skin cells. In the past synthetic materials such as microplastics were used in exfoliants. Nevertheless, a notable shift towards environmentally friendly can be observed.

At the same time, there is an increasing tendency among consumers to choose cosmetic products containing natural and organic ingredients. This is due to growing awareness of the advantages that natural exfoliants can offer, as they contain bioactive compounds such as antioxidants, polyphenols, and essential fatty acids. These compounds not only physically cleanse the skin but also offer additional benefits such as antioxidant, anti-inflammatory, and skin barrier effects
Among the most promising natural exfoliants that have emerged are coffee grounds, rice powder, and jojoba seeds. Coffee grounds, which are a byproduct of coffee consumption, not only provide exfoliation but also deliver antioxidants such as

chlorogenic acids and caffeine to the skin. Rice powder, which has traditionally been used in Asian beauty regimens, provides exfoliation while also delivering ferulic and phytic acids to the skin, which are known to be skin brighteners. Similarly, jojoba seeds provide a mild exfoliant in the form of finely milled powder that also delivers wax esters similar to the skin's own sebum.

In spite of the increased interest in these natural ingredients, there is a lack of comprehensive comparative studies on their effectiveness in stable emulsion systems. For example, the size, shape, and hardness of the particles can greatly influence not only the effectiveness of the exfoliating agent, but the overall physicochemical properties of the final product. The addition of solid particles in the formulation can greatly influence the overall properties, such as viscosity, pH, and sensory properties, which must be well understood.

This chapter provides the theoretical basis for the experiments that will be conducted. It begins with a general overview of cosmetic products and their importance. After that, the general structure and functions of the skin are examined, particularly the stratum corneum and its role t in the natural process of desquamation.

I .2. Cosmetic Products: Definition and Importance

I .2.1. Definition of Cosmetic Products

The word "cosmetic" comes from the ancient Greek word "kosmētikos," which denotes the ability to adorn, arrange, or decorate. Over time, this concept has evolved from simple aesthetic methods to intricate formulations meant to interact with the skin's biochemistry. (Namrita Lall, 2020)

The U.S. Food and Drug Administration (FDA) defines cosmetics as "articles intended to be applied to the human body for cleansing, beautifying, promoting attractiveness, or altering the appearance without affecting the body's structure or functions" (FDA). This broad definition, which includes any substance intended to be used as an ingredient in a cosmetic product, specifically excludes ordinary soap, according to the FDA. (Service, 2023)

It is critical to distinguish between drugs from cosmetics. While drugs are intended to diagnose, cure, alleviate, treat, or prevent disease, cosmetics are solely intended for beautifying cleansing or changing appearance without affecting the structure or function of the body. Products such as anti-dandruff shampoo, fluoride toothpaste, and antiperspirant deodorant are considered both cosmetics and pharmaceuticals because they contain active ingredients used to treat or prevent specific conditions. Cosmeceuticals, which are products containing biologically active ingredients meant to have therapeutic benefits on the skin, constitute an intermediate category even though this term is not officially recognized in regulatory systems. (Jumana Rashid, 2023)

I .2.2. Classification of Cosmetic Products

Cosmetic products can be categorized based on a number of factors, such as their regulatory category, formulation type, and intended purpose. The most common classification is based on the primary purpose and region of application. The main categories of cosmetic products are shown in the following table based on their intended use:

Table I.1: Classification of Cosmetic Products

Category	Examples	Description
Skin Care Products	Cleansers, Moisturizers, Sunscreens, Anti-aging product	Products designed to maintain, protect, and improve the skin
Color Cosmetics	Lipstick, Foundation, Eyeshadow, Mascara	Products used to enhance or alter appearance
Hair Care Products	Shampoos, Conditioners, Hair dyes, Styling products	Products for cleaning, conditioning, and styling hair
Oral and Dental Care Products	Toothpaste, Mouthwash	Products used for oral hygiene and dental care
Personal Hygiene Products	Deodorants, Antiperspirants	Products that control body odor and perspiration
Sun Care Products	Sunscreens, After-sun products	Products that protect the skin from UV radiation
Specialty Products	Baby products, Feminine hygiene, Hair removal products	Products designed for specific uses or target groups

(Raut Pranali Prakash, 2024)

According to Formulation Type:

Table I.2: Classification of Cosmetic products by Dosage Form

Dosage Form	Examples	Description
Solutions	Toners, Perfumes	Homogeneous systems where ingredients are completely dissolved in a solvent
Emulsions	Creams, Lotions	Mixtures of two immiscible phases (oil and water), such as O/W or W/O
Suspensions	Liquid foundations	Solid particles dispersed in a liquid medium
Gels	Hair gels, Face gels	Semi-solid systems with a three-dimensional polymer network
Ointments	Heavy creams	Semi-solid, greasy preparations with high oil content
Pastes	Toothpaste	Semi-solid systems with a high proportion of solid particles
Powders	Face powders, Talc	Dry, solid particulate systems
Aerosols / Sprays	Deodorant sprays	Products delivered using a propellant system

(Loyd V. Allen, 2014)

I 2.3. Importance of Cosmetic Products in Daily Life

In today's world, cosmetics are used for purposes beyond just beauty.

I .2.3.1. Protection and Skin Health

Cosmetic products are beneficial for the skin because they help protect it from external aggressors such as pollution and ultraviolet radiation. They form a protective barrier on the skins surface. Moisturizers are particularly important as they help maintain skin hydration and support proper skin function. The skin has a barrier and moisturizers support that. Sunscreens are also essential because they protect the skin from the sun’s ultraviolet rays. These rays can cause significant damage including premature aging and even cancer. Therefore sunscreens and similar products play a crucial role in maintaining skin health and safety. Cosmetic products are thus valuable tools for preserving our skin health and protection. (A. PANICO1, 2019)

I .2.3.2. Hygiene and Personal Care

Many cosmetic products fulfill essential hygienic roles, with cleansers, shampoos, soaps, and deodorants promoting personal cleanliness and preventing body odor, while toothpastes and mouthwashes support oral hygiene and dental health. (Kuchimova, 2026)

I.2.3.3. Psychological and Social Well-being

The use of cosmetic products is closely tied to self-esteem, confidence, and social interaction, with many users reporting improved psychological well-being and greater satisfaction with their appearance, which has led the cosmetic industry to become a key part of modern culture, fulfilling both aesthetic and emotional needs. (Lixia Zhang, 2020)

I .2.4. Regulatory Requirements for Cosmetic Products

The regulatory landscape for cosmetics is designed to prioritize public health through various localized frameworks. Under the EU Regulation (EC) No 1223/2009, compliance hinges on thorough safety evaluations and mandatory notifications, distinguished further by its comprehensive prohibition of animal testing. (European, 2009)

In 2022, the United States enacted the Modernization of Cosmetics Regulation Act (MoCRA), marking a pivotal update to federal oversight. Central to this act are the new requirements for facility registration and formal reporting of adverse events, ensuring a higher standard of accountability. (Administration, 2025)

In Algeria, the Ministry of Health oversees the safety and compliance of cosmetic products. However, to maintain focus on the core objectives of this study, a detailed regulatory review is not provided as the priority is the formulation and performance evaluation of natural exfoliating creams.

I .2.5. Cosmetic Formulations: Emulsions and Suspensions

I .2.5.1. Definition of Emulsions

Cosmetic creams function as emulsions, effectively integrating oil and water-two naturally immiscible phases-into a uniform texture. This stability depends entirely on the presence of an emulsifying agent, which prevents the inherent tendency of the liquids to separate into distinct layers. (O.Barel & al, 2009)

I .2.5.2. Types of Emulsions

Table I .3: Types of Emulsions

Type	Description	Example	Characteristics
Oil-in-water(O/W)	Oil droplets dispersed in a continuous water phase	Facial creams, lotions	Non- greasy, easily spreadable, rinses off easily
Water-in-Oil(W/O)	Water droplets dispersed in a continuous oil phase	Night creams cold creams	Greasy, more occlusive, provides better hydration

(Małgorzata Kowalska, 2023)

I .2.5.3. Definition of Suspensions

Insoluble solid particles, such as coffee grounds, rice powder, or jojoba seeds, are incorporated as a dispersed phase within the emulsion matrix to create exfoliating creams. To guarantee consistent application, these agents must be uniformly suspended throughout the cream. These particles act as mechanical abrasives when applied topically; the kinetic friction that results helps corneocytes physically separate from the stratum corneum, increasing cellular turnover and improving skin texture. (Tadros, 2018)

I .2.5.4. Factors Affecting Suspension Stability

Table I.4: Factors Affecting Exfoliation

Factor	Effect
Particle size	Smaller particles remain suspended longer; larger particles settle faster
Particle shape	Irregular shapes may affect flow properties and skin feel
Particle density	Particles with density similar to the liquid medium stay suspended better
Viscosity of the medium	Higher viscosity slows down particle settling
Presence of suspending agents	Thickeners help keep particles uniformly distributed

(Balasundaresan & al, 2025)

I .2.5.5. Key Physicochemical Parameters for Exfoliating Creams

When formulating exfoliating creams, several parameters must be evaluated to ensure product quality and safety:

Table I.5: Key Physicochemical Parameters for Exfoliating Creams

Parameter	Recommended range for facial products	Importance
pH	4.5 – 6.5	Must be compatible with skin's natural pH to avoid irritation
Viscosity	Depends on formulation	Determines spread ability and product feel
Spread ability	Easy and uniform	Affects how easily the cream covers the skin
Stability	No phase separation, color change, or odor change	Ensures product remains effective throughout shelf life

(Iin & al, 2025)

I .2.5.6. Application to the Present Study

The experimental phase of this study involves the formulation of three distinct exfoliating creams, utilizing oil-in-water (O/W) emulsions as the structural base. This specific emulsion type was selected for its superior suitability for facial applications; O/W systems offer a non-occlusive, non-greasy sensory profile, ensuring optimal spreadability and easy removal with water.

The primary exfoliating agents evaluated in these formulations are as follows:

I .2.5.6.1. Coffee grounds – provide mechanical exfoliation and contain antioxidants (caffeine and chlorogenic acids). According to (Janczarek, 2025), spent coffee grounds (SCGs) are a promising raw material for cosmetic scrubs, as they offer gentle abrasive properties and a naturally pleasant aroma. The stability of the emulsion base is crucial for scrub production, and the choice of emulsifier directly affects the product's physical properties including viscosity and texture.

I .2.5.6.2. Rice powder- provides gentle mechanical exfoliation and contains skin-brightening agents (ferulic acid and phytic acid). (Fan Yang, al, 2025)

I .2.5.6.3. Jojoba seeds- provide mild mechanical exfoliation and contain wax esters similar to human sebum. (Autumn Roberts, 2021)

The three formulations will be compared in terms of their physicochemical properties (pH, viscosity, spreadability, stability) to determine the most stable and effective formulation for skin application.

I .3. Skin Structure and Function

I 3.1. Overview of the Skin

Accounting for roughly 15% of an individual's total body mass, the skin is far more than a mere outer covering; it is the body's largest and most dynamic organ. It functions as a critical physiological interface, shielding internal systems from environmental threats-whether mechanical, chemical, or biological. Beyond its protective capacity, the integumentary system is essential for maintaining homeostatic balance through thermoregulation and prevention of excessive moisture loss, while its dense neural network facilitates our primary engagement with the physical world through touch. (Lopez-Ojeda & al, 2022)

I .3.2. Layers of the Skin

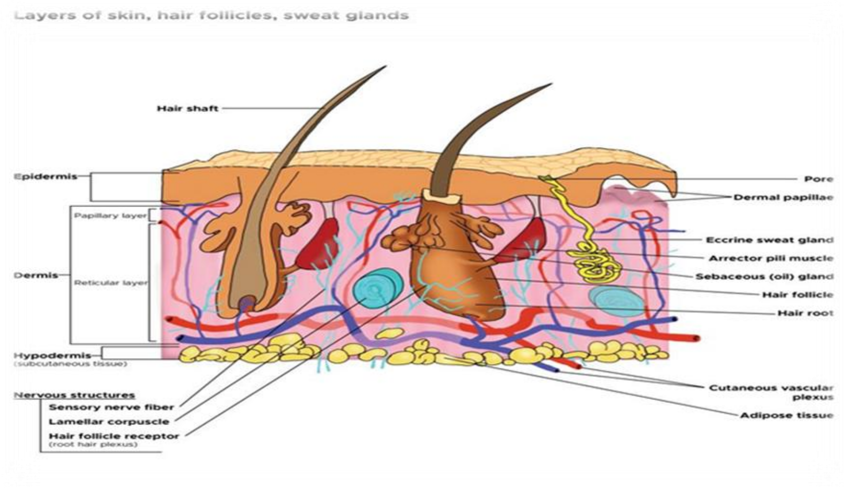


Figure I .1: Layers of human skin

The skin is composed of three main layers, each with distinct structures and functions:

Table I.6: Main Layers of the Skin and Their Functions

Layer	Location	Main Function
Epidermis	Outermost layer	Protection, barrier function, cell renewal
Dermis	Middle layer	Strength, elasticity, contains blood vessels and nerves
Hypodermis (Subcutaneous layer)	Deepest layer	Fat storage, insulation, shock absorption

(Arda & al, 2014)

I .3.3. The Epidermis: Detailed Structure

The epidermis, a stratified squamous epithelium dominated by approximately 90% kerationocytes, constitutes the external interface of the skin and the focal point of exfoliative renewal. Being avascular in nature, this layer maintains its metabolic functions through nutrient diffusion from the underlying dermal layers, illustrating a complex physiological dependency between the skin's various strata. (Yousef & al, 2024)

I .3.4. Layers of the Epidermis

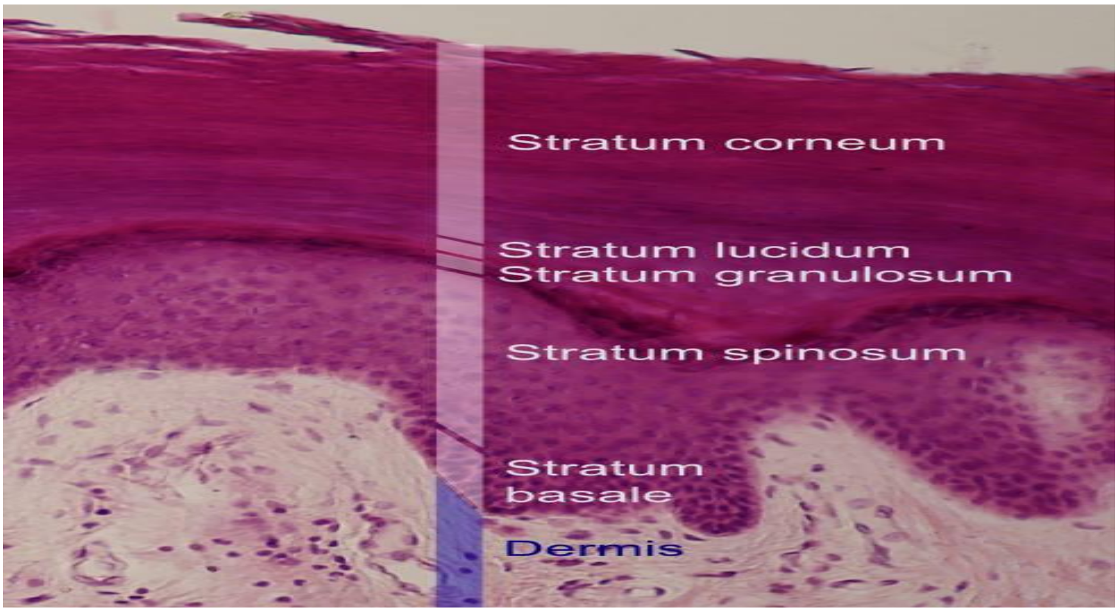


Figure I .2: Layer of the epidermis

The epidermis consists of five distinct layers (from deepest to most superficial):

Table I.7: Layers of the Epidermis and Their Characteristics

Layer	Name	Description
Stratum Basale	Basal layer	Deepest layer, contains dividing cells (keratinocytes stem cells)
Stratum spinosum	Spiny layer	Cells begin to differentiate and produce keratin
Stratum granulosum	Granular layer	Cells contain keratohyalin granules; beginning of cell death
Stratum lucidum	Clear layer	Present only in thick skin (palms and soles)
Stratum corneum	Horny layer	Outermost layer; composed of dead, flattened corneocytes

(Divyansh Sahu, 2024)

I .3.5 The Stratum Corneum and Desquamation

Positioned as the outermost boundary of the epidermis, the stratum corneum serves as the functional interface for desquamation. This layer comprises a dense arrangement of 15 to 20 strata of flattened, non-viable corneocytes, which undergo a continuous cycle of shedding and regeneration. The structural integrity of this layer is maintained by Cornedesmosomes-specialized protein complexes-while an interlocking lipid matrix ensures the preservation of the skin's essential barrier properties.

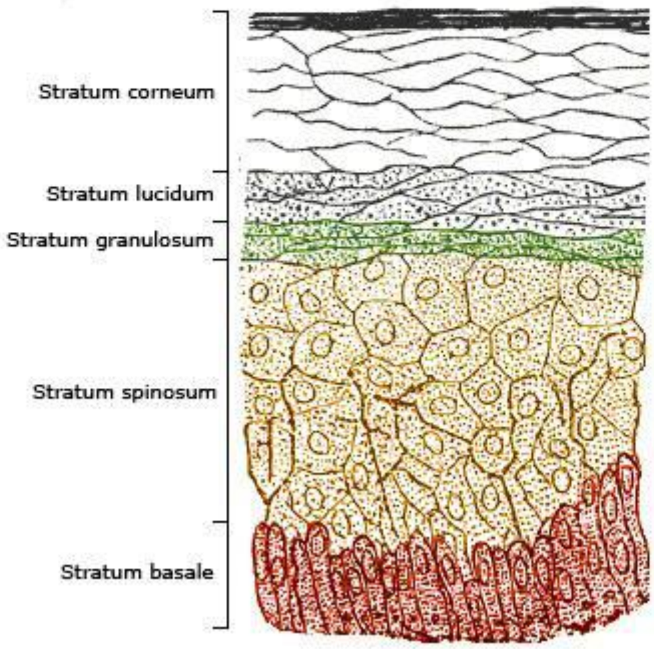


Figure I .3: Desquamation – shedding of dead corneocytes from the stratum corneum surface.

The natural shedding of corneocytes, or desquamation, is a highly regulated process that typically concludes 14 days after a corneocyte is formed. Central to this exfoliation cycle is the enzymatic degradation of Cornedesmosomes, a task primarily executed by kallikreins. The catalytic activity of these enzymes is notably sensitive to the local microenvironment, relying on precise gradients of humidity and pH to maintain the equilibrium of the skin surface. (Zani MB, 2022)

I .3.6 Factors Affecting Desquamation

Several factors can disrupt the normal desquamation process, leading to the accumulation of dead cells on the skin surface:

Table I.8: Factors Affecting the Desquamation Process

Factor	Effect on Desquamation
Aging	Slows down cell turnover rate; desquamation takes longer
Environmental pollution	Damages corneodesmosome degradation enzymes
Dry skin conditions	Reduces activity of kallikrein enzymes
UV radiation	Thickens the stratum corneum and impairs shedding
Certain skin diseases (Psoriasis, eczema, and ichthyosis)	disrupt normal shedding

(Parrado‹al, 2019)

Disruptions in the shedding process facilitate the retention of redundant corneocytes, directly contributing to:

• A dull, non-reflective aesthetic due to uneven surface light scattering.

• Heightened surface roughness driven by excessive cornification.

• Increased pore blockages facilitating the development of localized imperfections.

• Reduced efficacy of topicals: as the thickened stratum corneum acts as a physical barrier to product absorption. (Byel Kim, 2020)

I .3.7. Role of Exfoliation in Skin Maintenance

Exfoliation is the artificial acceleration of the desquamation process. It can be achieved through:

Table I.9: Types of Exfoliations and Their Mechanisms

Type	Method	Mechanism
Physical exfoliation	Abrasive particles (coffee, rice, jojoba)	Mechanically removes corneocytes by friction
Chemical exfoliation	Alpha-hydroxy acids (AHAs), beta-hydroxy acids (BHAs), enzymes	Dissolves intercellular bonds holding corneocytes together

The benefits of regular exfoliation include:

- Removal of accumulated dead cells.
- Improved skin texture and smoothness.
- Enhanced skin radiance.
- Increased penetration of active ingredients in skincare products.
- Stimulation of cellular renewal. (Yang, 2018)

I .3.8 Relevance to the Present Study

The current investigation evaluates the efficacy of physical exfoliation using distinct natural abrasive agents, specifically coffee grounds, rice powder, and jojoba seeds. These constituents are incorporated to:

- Facilitate mechanical debridement by effectively dislodging accumulated corneocytes from the superficial stratum corneum.
- Re-establish desquamatory equilibrium by restoring the skin’s innate self-renewal kinetics. (Elezović, 2025)
- Refine cutaneous morphology by enhancing both tactile smoothness and overall optical radiance.
- Exert synergistic bioactive effects by delivering essential antioxidants, fatty acids, and vitamins to the epidermal matrix. (Dr. Hari Om Saxena, 2022)

The three natural exfoliants selected for this study are particularly suitable because they offer:

1. Effective mechanical abrasion without causing micro-tears in the skin. (Alisa Elezović, 2025)

2. Biodegradability – environmentally friendly compared to plastic microbeads. (Magrini, 2017)

3. Additional skin benefits – antioxidant, anti-inflammatory, and moisturizing properties. (Fan Yang, 2025)

I .4. Exfoliation: Definition and Mechanisms

I 4.1. Definition of Exfoliation

Exfoliation is defined by IUPAC as the structural separation of layers in a multi-laminated system. Within the scope of skincare, this process targets the removal of accumulated corneocytes from the epidermis's outermost layer. Although desquamation serves as the body’s innate exfoliative mechanism, the application of targeted chemical or mechanical treatments allows for regulated acceleration of this process, which is essential for maintaining skin vitality and improving its textural characteristics.

I .4.2. Natural Exfoliation (Desquamation)

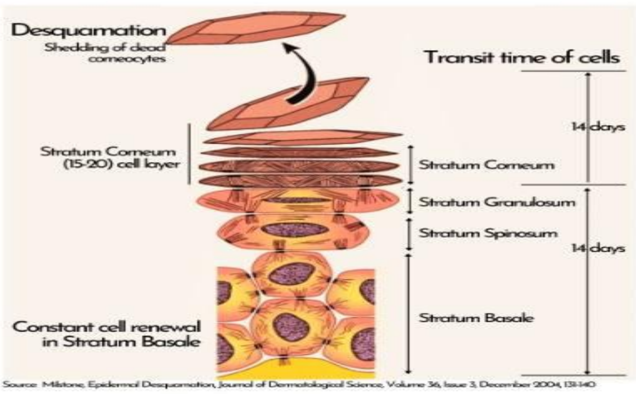


Figure I.4: Natural desquamation process off the skin

Desquamation is the natural, continuous process by which corneocytes are shed from the skin surface. Under normal physiological conditions, this process takes approximately 14 days from the formation of a corneocyte in the stratum basale to its shedding from the stratum corneum.

The shedding process is regulated by enzymes called kallikreins, which degrade the Cornedesmosomes (protein structures that hold corneocytes together). These enzymes are activated under specific pH and humidity conditions. (Caubet & al, 2004)

I .4.3. Artificial Exfoliation: Definition and Purpose

Artificial exfoliation is the deliberate acceleration of the desquamation process using external agents. This practice has become a cornerstone of modern skincare routines because it offers several benefits:

Table I.10: Benefits of Artificial Exfoliation

Benefit	Description
Removal of dead cells	Eliminates accumulated corneocytes that cause dullness
Improved texture	Smooths rough skin surfaces
Enhanced radiance	Reveals fresher, brighter skin underneath
Unclogs pores	Prevents blackheads and whiteheads
Better product absorption	Allows active ingredients to penetrate more effectively
Stimulates cell renewal	Promotes faster turnover of keratinocytes

(Milstone., 2004)

I 4.4. Types of Artificial Exfoliation

Artificial exfoliation is broadly classified into two main types based on the mechanism of action:

Table I.11: Types of Artificial Exfoliation

Type	Mechanism	Examples
Physical (Mechanical) Exfoliation	Uses abrasive particles or tools to manually remove dead cells by friction	Scrubs (coffee, sugar, salt), brushes, sponges
Chemical Exfoliation	Uses acids or enzymes to dissolve the intercellular bonds holding dead cells together	AHAs (glycolic, lactic), BHAs (salicylic), enzymes (papain, bromelain)

(Yang., 2018)

I .4.5. Physical (Mechanical) Exfoliation

I .4.5.1. Mechanism of Action

Physical exfoliation relies on friction created by abrasive particles or tools to mechanically detach and remove dead corneocytes from the skin surface.

The effectiveness of physical exfoliation depends on several factors:

Table I.12: Factors Affecting Physical Exfoliation Efficiency

Factor	Effect on Exfoliation
Particle size	Smaller particles provide gentler exfoliation; larger particles are more aggressive
Particle shape	Rounded particles are less damaging; irregular particles may cause micro-tears
Applied pressure	Greater pressure increases abrasion but also increases risk of injury
Duration of rubbing	Longer contact time removes more cells but may irritate
Particle hardness	Harder particles exfoliate more aggressively

(Piotrowska & al, 2020)

I .4.5.2. Advantages and Disadvantages of Physical Exfoliation

Table I .13: Advantages and Disadvantages of Physical Exfoliation

Advantages	Disadvantages
Immediate visible results	Can cause micro-tears if particles are irregular
Simple to use	Risk of over-exfoliation and barrier damage
Provides sensory feedback ("clean feel")	May worsen inflammatory skin conditions (acne, rosacea)
Inexpensive	Uneven exfoliation (missed spots or over-scrubbing)
Suitable for non-sensitive body areas	Not recommended for sensitive skin types

(Farage, 2022)

I .4.6. Chemical Exfoliation

I .4.6.1. Mechanism of Action

Chemical exfoliation works by applying acids or enzymes to the skin that dissolve the intercellular bonds (specifically, the desmosomes) holding corneocytes together. Unlike physical exfoliation, no rubbing or friction is required.

The most common chemical exfoliants include:

Table I.14: Types of Chemical Exfoliants and Their Characteristics

Category	Examples	Mechanism	Best For
AHAs (Alpha Hydroxy Acids), mandelic acid	Glycolic acid, lactic acid	Water-soluble; dissolve bonds on skin surface	Dry, sun-damaged, aging skin
BHAs (Beta Hydroxy Acids)	Salicylic acid	Oil-soluble; penetrates deep into pores	Oily, acne-prone, congested skin
PHAs (Polyhydroxy Acids)	Gluconolactone, lactobionic acid	Larger molecules; gentler than AHAs	Sensitive skin
Enzymes	Papain (papaya), bromelain (pineapple)	Break down keratin proteins	Sensitive skin, beginners

(Mukovozov., 2023)

I .4.6.2. Advantages and Disadvantages of Chemical Exfoliation

Table I .15: Advantages and Disadvantages of Chemical Exfoliation

Advantages	Disadvantages
Even, uniform exfoliation	Results take longer to appear (4-6 weeks)
No friction or mechanical damage	Can cause stinging or burning if concentration too high
Penetrates pores (BHAs)	Increases photosensitivity (especially AHAs)
Suitable for sensitive skin (with proper formulation)	Requires consistent use for maintenance
Can be combined with other active ingredients	May cause purging (initial breakout)

(Moghimipour, 2012)

I .4.7. Comparison between Physical and Chemical Exfoliation

Table I.16: Comparison between Physical and Chemical Exfoliation

1. Comparison Aspect	2. Physical Exfoliation	3. Chemical Exfoliation
Mechanism	Mechanical friction	Dissolves intercellular bonds
Results	Immediate	Gradual (4-6 weeks)
Depth of action	Surface only	Surface (AHAs) or deep into pores (BHAs)
Risk of micro-tears	High with irregular particles	None
Risk of irritation	Moderate to high	Low to moderate (depends on concentration)
Suitability for sensitive skin	Not recommended	Yes (with PHAs or low concentrations)
Sensory experience	Scrubby, "clean" feel	No physical sensation
Sun sensitivity	Low	Moderate to high (especially AHAs)
Best for	Body skin, oily non-sensitive skin	Face, sensitive skin, acne-prone skin

(Dermobrain, 2026)

I .4.8. Relevance to the Psresent Study

The present study focuses exclusively on physical (mechanical) exfoliation using natural abrasive agents derived from plant sources:

I .4.8.1. Coffee Grounds – They offer good mechanical exfoliation with round grains; antioxidant properties from caffeine and chlorogenic acids.

I .4.8.2. Rice Powder – It provides gentle exfoliation with small grains; skin lightening effect from ferulic acid and phytic acid.

I .4.8.3. Jojoba Seeds – They offer mild exfoliation with smooth and waxy grains; wax esters similar to human sebum.

The following natural exfoliating agents have been chosen due to their:

- **Biodegradability** - Environmentally friendly agent that is free of plastic microbeads.
- **Two-in-one function** - Exfoliation alongside other bioactive properties.
- **Safety** - Reduced chance of micro-tears caused by irregular artificial particles.

I .5. Factors Affecting Exfoliation Efficiency

The effectiveness of exfoliation is influenced by several physical and chemical factors, most notably pH, the type and concentration of exfoliating agents, particle size, and skin type (Şoimiţa Emiliana Măgeruşan, 2023). Alpha-hydroxy acids (AHAs) and beta-hydroxy acids (BHAs) are among the most important factors affecting the efficiency of chemical exfoliation. AHAs, such as glycolic acid, work by exfoliating the skins surface by dissolving the bonds between dead cells in the stratum corneum, thereby improving skin texture and radiance. In contrast, BHAs, particularly salicylic acid, are lipid-soluble, which allows them to penetrate pores and cleanse them from within, making them more effective for oily and acne-prone skin. (Segre, 2025)

Moreover, pH plays a crucial role in the effectiveness of both AHAs and BHAs, as these acids are more active in an acidic environment (typically between PH 3 and 4), which enhances their exfoliating action. However, using high concentrations or very low pH levels may lead to skin irritation, especially for individuals with sensitive skin (Almeman, 2024).In addition, the concentration of acids directly affects the intensity of exfoliation: higher concentrations yield faster results but increase the risk of irritation. Skin type also remains an important factor in determining tolerance to these agents, as sensitive skin prefers lower concentrations, whereas oily skin can generally tolerate relatively higher concentrations. (Manjula Nayak, 2021)

I .6. Natural Exfoliating Agents

Natural exfoliants are seeing increasing use in skincare products because of their effectiveness, safety, and biocompatibility with the skin. They are promising alternatives to synthetic scrubs, especially given the growing interest in eco-friendly products. The mechanism of natural scrubs often relies on mechanical action or the presence of active compounds that help remove dead cells and stimulate skin regeneration. (Joana Marto, 2018)

I.6.1. Coffee:

Coffee grounds are used as a natural exfoliant and are effective due to their relatively coarse particles which facilitate the mechanical removal of dead cells. they also contains phenolic compounds and antioxidants such as caffeine, which contribute to improved blood circulation and reduced dermal inflammation, thereby promoting skin health and radiance.

I .6.2. Rice:

As one of the oldest skincare ingredients still in use today, rice acts as a mild exfoliant that helps remove impurities and dead skin cells without causing irritation. It contains beneficial compounds such as B vitamin and antioxidants that help help brighten the skin and improve its texture. (Yorke, 2021)

I.6.3. Jojoba Beads:

Jojoba beads are biodegradable and known for their spherical smooth shapetu, making them an ideal choice for gentle physical exfoliation without causing micro-tears or skin damage.

I .7. Advantages of Natural Exfoliants

Natural exfoliants offer numerous advantages that make them a preferred choice in modern skincare formulations, especially given the increasing focus on safe and sustainable products. They are composed of naturally derived components, thereby providing better biocompatibility with the skin compared tosynthetic exfoliators.

I .7.1. Safety and Skin Compatibility:

Natural exfoliants are less irritating because they contain gentle, often chemical-free ingredients. Many also contain beneficial compounds such as vitamins and antioxidants that support skin health and function. (FAO, 2022)

I.7.2. Environmental Friendliness:

Natural materials are biodegradable and therefore minimize environmental pollution compared to synthetic scrubs containing microplastics, which has become increasingly important due to global environmental concerns. (UNEP, 2021)

I .7.3. Rich in Bioactive Compounds:

Natural exfoliants are rich in active compounds such as polyphenols, vitamins, and natural acids, which improve skin appearance by reducing inflammation, enhancing cell renewal, and combating free radicals. (Amin. , 2021)

I .7.4. Consumer Preference and Market Trends:

Consumers increasingly prefer natural products due to growing awareness of potential risks associated with synthetic chemicals, leading to higher demand for clean and organic cosmetics. (Baki & Alexander, 2015)

I .7.4. Biodegradability:

Natural exfoliants are biodegradable and environmentally sustainable compared to synthetic alternatives. (Baki & Alexander, 2015)

I.7.5. Low Risk of Micro-tears:

Natural spherical particles such as jojoba beads reduce skin damage compared to irregular synthetic particles.

I .7.6. Cost-Effectiveness:

Natural materials are generally inexpensive and widely available, particularly agro-industrial by-products such as coffee.

I.7.8. Multifunctionality:

Due to the presence of bioactive compounds such as antioxidants, natural exfoliants provide multiple skincare benefits beyond exfoliation. (Manjula Nayak, al, 2021)

I.7.9. Reduced Chemical Load:

Using natural ingredients reduces exposure to synthetic chemicals and their potential side effects.

I .7.10. Better Consumer Acceptance:

Increased consumer awareness has led to a preference for safer, natural-based cosmetic products.

Compatibility with Green Formulation Trends:

Natural exfoliants align with green chemistry principles and sustainable cosmetic development.

I .8. Formulation of Exfoliating Creams

The formulation of exfoliating creams is a fundamental step in the development of effective and safe cosmetic products, as it relies on combining different ingredients in carefully studied proportions to obtain a stable product with suitable properties for skin application. These creams are typically in the form of emulsions, either oil-in-water (O/W) or water-in-oil (W/O), depending on the intended use and target skin type. (CTFA, 2004)

I .8.1. Basic Components of Exfoliating Creams:

Exfoliating creams consist of several key components, including:

- **Oil phase:** contains oils and emollients that help moisturize the skin and improve its softness.
- **Aqueous phase:** contains water and soluble substances such as humectants.
- Emulsifiers: used to combine the oil and water phases and maintain emulsion stability.
- **Preservatives:** prevent microbial growth and extend the product’s shelf life.

- **Exfoliating agents:** such as coffee, rice, or acids (AHA/BHA), which are responsible for removing dead skin cells.

I.8.2. Formulation Process:

Creams are formulated by heating the oil and aqueous phases separately to the same temperature (usually between 70 and 75°C), then mixing them under continuous stirring to form a homogeneous emulsion. The mixture is then allowed to cool gradually with continuous stirring, after which heat-sensitive ingredients such as preservatives, fragrances, and exfoliating agents are added.

I.8.3. Factors Affecting Formulation Stability:

The stability of exfoliating creams depends on several factors, including the type and concentration of emulsifier, pH, particle size of the dispersed phase, and storage conditions such as temperature and light. Any imbalance in these factors may lead to phase separation or changes in the product consistency.

I .8.4. Incorporation of Natural Exfoliants:

When using natural materials such as coffee or rice, it is important to consider particle size and distribution within the cream to ensure effective exfoliation and avoid skin irritation. It is also necessary to ensure compatibility with other formulation components to maintain product stability and quality. (Almeman A. A., 2024)

I .9. Evaluation of Exfoliating Creams

The evaluation of exfoliating creams is a crucial step to ensure product quality, efficacy, and safety before use. This process includes a range of physical, chemical, and microbiological tests aimed at determining the product's characteristics and compatibility with the skin. (Brigitte Dréno, 2020)

I.9.1. pH Measurement:

pH measurement is one of the most important tests, as the cream should be compatible with the skin's pH (typically between 4.5 and 6.5). This helps maintain the integrity of the skin barrier and reduces the risk of irritation, especially in products containing exfoliating acids such as AHAs and BHAs. (Teo BSX, 2021)

I .9.2. Viscosity:

Viscosity determines the consistency of the cream and its ease of application on the skin. It is measured using a Brookfield viscometer and influences both product stability and user acceptability. (Mägeruşan, 2023)

I .9.3. Spread ability:

Spread ability reflects how easily the cream can be distributed over the skin surface. It is an important property to ensure uniform coverage and better efficacy, and it is typically measured using mechanical methods based on a specific weight and spreading time.

I.9.4. Particle Size Analysis:

Particle size of exfoliating agents is an important factor in determining both the efficacy and safety of the product. Smaller particles provide gentle exfoliation, whereas larger particles may cause skin irritation.

I .9.5. Stability Testing:

Stability testing aims to evaluate the cream's stability under various conditions such as temperature, light, and storage. This includes monitoring any changes in color, odor, or consistency, as well as potential for phase separation.

I .9.6. Skin Irritation Test:

This test assesses the safety of the product when applied to the skin, ensuring that it does not cause redness or allergic reactions, particularly in products containing active ingredients.

I.10. Previous Studies (Literature Review)

This field has advanced significantly due to recent research on exfoliating products, where many research works have evaluated the efficacy and safety of exfoliating cream ingredients, whether natural or synthetic.

I .10.1. Studies on Acids – AHA/BHA:

Numerous studies have investingated organic acids, such as alpha-hydroxy acids (AHAs), in chemical exfoliation, demonstrating their ability to improve skin texture, and reduce wrinkles, pigmentation, and acne by stimulating cell renewal and removing the stratum corneum. These studies also emphasized the importance of controlling acid concentration and pH to minimize irritation and ensure safety.

I .10.2. Studies on Natural Exfoliants:

Recently, there has been growing interest in natural exfoliants and their effects on the skin. Several studies have shown that plant-based materials such as coffee and rice contain active compounds that can be used for exfoliation and improving skin appearance safely, in addition to their antioxidant and anti-inflammatory properties.

I .10.3. Studies on Modern Formulations:

According to recent research, the development of exfoliating products no longer depends solely on the exfoliating agent but also involves the incorporation of active ingredients such as moisturizers and antioxidants to maintain skin health and enhance the skin barrier. Studies have also shown that interactions between formulation components play an important role in achieving both efficacy and stability.

I .11. Chapter Summary

In this chapter, an overview of cosmetics and their importance has been provided, emphasizing the structure and functions of the skin as the body's primary barrier. The concept of exfoliation was also discussed along with its mechanisms, types, including physical and chemical peeling, highlighting the role of alpha-hydroxy and beta-hydroxyl acids in improving cell regeneration. In addition, factors affecting the efficiency of exfoliation were mentioned, such as pH, concentration of active ingredients, and skin type. Furthermore, natural exfoliating agents such as coffee, rice, and jojoba were discussed, highlighting their advantages compared to synthetic exfoliants, especially in terms of safety and sustainability. Moreover, the fundamentals of cosmetic exfoliating cream formulation and evaluation methods using different physical and chemical tests were highlighted. Finally, previous studies supporting the use of natural components in developing safe and effective exfoliating creams creams were reviewed.

Reference

1. Allen, L. V., & Ansel, H. C. (2014). Ansel's pharmaceutical dosage forms and drug delivery systems (10th ed.). Lippincott Williams & Wilkins.
2. Almeman, A. A. (2024). Alpha-Hydroxy acids in dermatological practice: A comprehensive clinical and legal review. Clinical, Cosmetic and Investigational Dermatology, 17, 1661–1685. https://doi.org/10.2147/CCID.S453243
3. Arda, O., Göksügür, N., & Tüzün, Y. (2014). Basic histological structure and functions of facial skin. Clinics in Dermatology, 32(1), 3–13. https://doi.org/10.1016/j.clindermatol.2013.05.021
4. Baki, G., & Alexander, K. (2021). Introduction to cosmetic formulation and technology. Wiley. https://doi.org/10.1002/9781118762925
5. Balasundaresan, M., Senthilkumar, S. K., Kumaravelu, K., Kumaresan, R., Tamilarasi, M., Vijayashree, N., & Vinodhini, P. (2025). Suspension – A brief review. World Journal of Pharmaceutical Research, 14(4), 306–325. https://doi.org/10.20959/wjpr20254-35539
6. Barel, A. O., Paye, M., & Maibach, H. I. (Eds.). (2009). Handbook of cosmetic science and technology (3rd ed.). Informa Healthcare.
7. Caubet, C., Jonca, N., Brattsand, M., Guerrin, M., Bernard, D., Schmidt, R., Egelrud, T., Simon, M., & Serre, G. (2004). Degradation of corneodesmosome proteins by two serine proteases of the kallikrein family, SCTE/KLK5/hK5 and SCCE/KLK7/hK7. The Journal of Investigative Dermatology, 122(5), 1235–1244.
8. Cosmetics Europe & CTFA. (2004). Guidelines on stability testing of cosmetic products.
9. DermoBrain Medical Editorial Team. (2026, June 3). Exfoliation guide: Physical vs chemical methods. DermoBrain. https://dermobrain.com/skincare/skincare-science/exfoliation-guide-physical-vs-chemical-methods.html

10. Elezović, A., Pehlivanović Kelle, B., Oras, A., Mujkić, H., Memić, M., Kojčin, E., Bulbulušić, M., Mujčinović, A., Nikolić, A., & Bečić, F. (2025). Caffeinated skincare development and optimization: Upcycling spent coffee grounds into natural exfoliants. Journal of Cosmetic Dermatology, 24(1), e70607. https://doi.org/10.1111/joed.70607
11. Food and Agriculture Organization of the United Nations. (2022). Contribution of terrestrial animal source food to healthy diets for improved nutrition and health outcomes: An evidence and policy overview on the state of knowledge and gaps (Draft).
12. Gad, H. A., Roberts, A., Hamzi, S. H., Gad, H. A., Touiss, I., Altyar, A. E., Kensara, O. A., & Ashour, M. L. (2021). Jojoba oil: An updated comprehensive review on chemistry, pharmaceutical uses, and toxicity. Polymers, 13(11), 1711. https://doi.org/10.3390/polym13111711
13. Jalolov, N. N., & Kuchimova, M. Sh. (2026). The medical importance of personal hygiene in the use of cosmetic products. American Journal of Research in Humanities and Social Sciences, 46.
14. Juliano, C., & Magrini, G. A. (2017). Cosmetic ingredients as emerging pollutants of environmental and health concern: A mini-review. Cosmetics, 4(2), 11. https://doi.org/10.3390/cosmetics4020011
15. Karwal, K., & Mukovozov, I. (2023). Topical AHA in dermatology: Formulations, mechanisms of action, efficacy, and future perspectives. Cosmetics, 10(5), 131. https://doi.org/10.3390/cosmetics10050131
16. Kim, B., Cho, H.-E., Moon, S. H., Ahn, H.-J., Bae, S., Cho, H.-D., & An, S. (2020). Transdermal delivery systems in cosmetics. Biomedical Dermatology, 4(1), 10. https://doi.org/10.1186/s41702-020-0058-7
17. Kowalska, M., Woźniak, M., & Ludwiński, P. (2023). Emulsions, their quality and importance in food, cosmetic, and pharmaceutical industries. Acta Poloniae Pharmaceutica-Drug Research, 80(6), 863–877. https://doi.org/10.32383/appdr/174249

18. Lall, N., Mahomoodally, M. F., Esposito, D., Steenkamp, V., Zengin, G., Steyn, A., & Oosthuizen, C. B. (2020). Editorial: Cosmeceuticals from medicinal plants. Frontiers in Pharmacology, 11, 1149. https://doi.org/10.3389/fphar.2020.01149
19. Lopez-Ojeda, W., Pandey, A., Alhajj, M., & Oakley, A. M. (2022). Anatomy, skin (integument). In StatPearls. StatPearls Publishing. https://www.ncbi.nlm.nih.gov/books/NBK441980/
20. Măgeruşan, Ş. E., Hancu, G., & Rusu, A. (2023). A comprehensive bibliographic review concerning the efficacy of organic acids for chemical peels treating acne vulgaris. Molecules, 28(20), 7219. https://doi.org/10.3390/molecules28207219
21. Marto, J., Neves, Â., Gonçalves, L. M., Pinto, P., Almeida, C., & Simões, S. (2018). Rice water: A traditional ingredient with anti-aging efficacy. Cosmetics, 5(2), 26. https://doi.org/10.3390/cosmetics5020026
22. Milstone, L. M. (2004). Epidermal desquamation. Journal of Dermatological Science, 36(3), 131–140. https://doi.org/10.1016/j.jdermsci.2004.05.004
23. Moghimipour, E. (2012). Hydroxy acids, the most widely used anti-aging agents. Jundishapur Journal of Natural Pharmaceutical Products, 7(1), 9–10.
24. Nayak, M., Sreedhar, D., Prabhu, S. S., & Ligade, V. S. (2021). Global trends in cosmetics use-related adverse effects: A bibliometric analysis of literature published during 1957–2021. Cosmetics, 8(3), 75. https://doi.org/10.3390/cosmetics8030075
25. Panico, A., Serio, F., Bagordo, F., Grassi, T., Idolo, A., De Giorgi, M., Guido, M., Congedo, M., & De Donno, A. (2019). Skin safety and health prevention: An overview of chemicals in cosmetic products. Journal of Preventive Medicine and Hygiene, 60(1), E50–E57.
26. Parrado, C., Mercado-Saenz, S., Perez-Davo, A., Gilaberte, Y., Gonzalez, S., & Juarranz, A. (2019). Environmental stressors on skin aging. Mechanistic insights. Frontiers in Pharmacology, 10, 759. https://doi.org/10.3389/fphar.2019.00759

27. Piotrowska, A., Czerwińska-Ledwig, O., Serdiuk, M., Serdiuk, K., & Pilch, W. (2020). Composition of scrub-type cosmetics from the perspective of product ecology and microplastic content. Toxicology and Environmental Health Sciences, 12(1), 75–81. https://doi.org/10.1007/s13530-020-00051-9
28. Prakash, R. P., Yogiraj, D. G., Ashok, J. S., & Vikas, G. A. (2024). Comprehensive overview of the cosmetic industry: Trends, challenges, & innovations. Journal of Emerging Technologies and Innovative Research, 11(6).
29. Rashid, J., Sabar, M. F., Gill, Z., Mustafa, U., Fatima, S., & Ashiq, S. (2023). Cosmeceuticals: The bioactive elements in new-age beauty products. International Journal of Pharmacy & Integrated Health Sciences, 4(2), 70–72. https://doi.org/10.56536/ijpihs.v4i2.98
30. Regulation (EC) No 1223/2009 of the European Parliament and of the Council of 30 November 2009 on cosmetic products (recast). (2009). Official Journal of the European Union, L342, 59–209.
31. Sahu, D., Sahu, P., Dubey, A., Jain, A., Sharma, H., & Sahu, G. K. (2024). Formulation and evaluation of herbal cold cream. International Journal of Creative Research Thoughts, 12(4), 721–723.
32. Saxena, H. O., Rao, G. R., Parihar, S., & Bhutiani, R. (Eds.). (2022). Chapter 14: Non-timber forest produce. In Non-Timber Forest Products: Opportunities and Challenges (pp. xx–xx). ANJALI COPIERS.
33. Scharschmidt, T. C., & Segre, J. A. (2025). Skin microbiome and dermatologic disorders. The Journal of Clinical Investigation, 135(3), e184315. https://doi.org/10.1172/JCI184315
34. Suhesti, I., Antari, E. D., Nasrina, S. C., & Putra, M. P. (2024). Formulation and physical stability testing of exfoliating gel and moisturizing gel from sugarcane bagasse extract. International Journal of Health and Pharmaceutical, 4(1), 46–56.
35. Szaferski, W., & Janczarek, M. (2025). Preparation of cosmetic scrub bases from coffee waste and eco-friendly emulsifiers. Cosmetics, 12(1), 31. https://doi.org/10.3390/cosmetics12010031
36. Tadros, T. F. (2018). Formulation science and technology: Vol. 3. Pharmaceutical, cosmetic and personal care formulations. Walter de Gruyter.

37. Tang, S.-C., & Yang, J.-H. (2018). Dual effects of alpha-hydroxy acids on the skin. Molecules, 23(4), 863. https://doi.org/10.3390/molecules23040863
38. Teo, B. S. X., Gan, R. Y., Abdul Aziz, S., Sirirak, T., Mohd Asmani, M. F., & Yusuf, E. (2021). In vitro evaluation of antioxidant and antibacterial activities of Eucheuma cottonii extract and its in vivo evaluation of the wound-healing activity in mice. Journal of Cosmetic Dermatology, 20(3), 993–1001. https://doi.org/10.1111/jocd.13624
39. United Nations Environment Programme. (2021). Drowning in plastics: Marine litter and plastic waste vital graphics.
40. U.S. Food and Drug Administration. (2025). Report on the use of PFAS in cosmetic products and associated risks. Office of the Chief Scientist, Office of Cosmetics and Colors.
41. Wells, N. (2023). FDA regulation of cosmetics and personal care products under the Modernization of Cosmetics Regulation Act of 2022 (MOCRA) (Report No. R47826). Congressional Research Service.
42. Yang, F., Hu, Y., Wu, M., Guo, M., & Wang, H. (2025). Biologically active components and skincare benefits of rice fermentation products: A review. Cosmetics, 12(1), 29. https://doi.org/10.3390/cosmetics12010029
43. Yorke, K., & Amin, S. (2021). High performance conditioning shampoo with hyaluronic acid and sustainable surfactants. Cosmetics, 8(3), 71. https://doi.org/10.3390/cosmetics8030071
44. Yousef, H., Alhajj, M., Fakoya, A. O., & Sharma, S. (2024). Anatomy, skin (integument), epidermis. In StatPearls. StatPearls Publishing. https://www.ncbi.nlm.nih.gov/books/NBK470464/
45. Zani, M. B., Sant'Ana, A. M., Tognato, R. C., Chagas, J. R., & Puzer, L. (2022). Human tissue kallikreins-related peptidases are targets for the treatment of skin desquamation diseases. Frontiers in Medicine, 8, 777619. https://doi.org/10.3389/fmed.2021.777619

46. Zhang, L., Adique, A., Sarkar, P., Shenai, V., Sampath, M., Lai, R., Qi, J., Wang, M., & Farage, M. A. (2020). The impact of routine skin care on the quality of life. Cosmetics, 7(3), 66. https://doi.org/10.3390/cosmetics7030066

Chapter II

Materials and Methods

II.1. Materials

The following materials were used for the preparation of the exfoliating creams.

II.1.1 Active Exfoliating Agents

Three natural exfoliating agents were used in this study:

Table II.1: Natural Exfoliating Agents Used in the Study

Agent	Form	Source
Coffee grounds	Very fine, dry powder	Spent coffee grounds, dried and sterilized
Rice powder	Ultra-fine powder (cosmetic grade)	Commercial rice powder
Jojoba seeds	Finely ground powder	Ground jojoba sseeds

II.1.2 Emulsion Base Ingredients

The oil-in-water (O/W) emulsion was formulated using the following ingredients:

Table II.2: Composition of the Oil-in-Water (O/W) Emulsion Base

Ingredient	Role	Percentage (%)
Phase A (Aqueous Phase)		
Distilled	water Main solvent	45.0
Aloe vera gel	Soothing and hydrating agent	15.0
Vegetable glycerin	Humectant	3.0
Disodium EDTA	Chelating agent (stabilizer)	0.1
Phase B (Oil Phase)		
Olivem 1000	Emulsifier (O/W)	6.0
Sweet almond oil	Nourishing emollient	10.0
Shea butter	Protective emollient	5.0
Beeswax	Texture agent and stabilizer	3.0
Phase C (Exfoliating Agent)		
Rice powder or coffee jojoba grounds	Mechanical exfoliant	8.0
Phase D (Additives)		
Vitamin E (Tocopherol)	Antioxidant	0.5
Cosgard (preservative)	Broad-spectrum preservative	0.8
Fragrance (essential oil)	Aroma	Few drops

Figure II.1: Raw materials used in the study

II .2. Equipment

The following equipment was used for the preparation and evaluation of the exfoliating creams:

Table II.3: Equipment Used for Cream Preparation and Evaluation

Equipment	Purpose
Precision balance (0.1 g accuracy)	Weighing ingredients
Two heat-resistant glass beakers (250 mL)	Preparing aqueous and oil phases
Water bath or double boiler	Heating phases
Infrared or laboratory thermometer	Temperature monitoring
Manual whisk or mini electric mixer	Emulsification
Silicone spatula	Mixing and transferring
Sterilized glass or plastic jars with lids	Product storage
70% alcohol	Disinfection of equipment
pH paper or pH meter	pH measurement (optional)
Refrigerator	Storage stability testing

Figure II.2: Equipment used for formulation and evaluation

II.3. Preparation Method

The exfoliating creams were prepared following the oil-in-water (O/W) emulsion method. All equipment was disinfected with 70% alcohol and allowed to dry before use.

Step 1: Weighing of Phases

- Aqueous Phase (A): In a beaker, weigh distilled water (45.0 g), aloe vera gel (15.0 g), vegetable glycerin (3.0 g), and disodium EDTA (0.1 g). Mix to dissolve the EDTA.
- Oil Phase (B): In a second beaker, weigh Olivem 1000 (6.0 g), sweet almond oil (10.0 g), shea butter (5.0 g), and beeswax (3.0 g).
- Exfoliating Phase ©: Weigh the exfoliating agent (rice powder or coffee grounds) (8.0 g) in a small container.
- Additives Phase (D): Prepare vitamin E (0.5 g) and Cosgard (0.8 g) for addition at controlled temperature.

Step 2: Heating of Phases

Both beakers (aqueous and oil phases) were placed in a water bath at 70-80°C. The phases were heated until all fatty substances were melted and the aqueous phase reached approximately 70-75°C. The temperature was maintained for 5 minutes to ensure complete dissolution and partial sterilization. Both phases were adjusted to the same temperature before emulsification.

Step 3: Emulsification

The two beakers were removed from the water bath. The aqueous phase was slowly poured into the oil phase while whisking vigorously (or using a mini electric mixer at moderate speed). Whisking was continued for 2-3 minutes. The mixture turned white and thickened gradually, indicating the formation of the emulsion. Olivem 1000 is an effective emulsifier that provides a smooth texture.

Step 4: Cooling and Additions

The mixture was stirred gently from time to time to ensure homogeneous cooling. When the temperature dropped below 40°C, vitamin E was added and mixed well. When the temperature reached 30-35°C, Cosgard was added and mixed thoroughly (Cosgard must be added at low temperature to preserve its efficacy). At this stage, the exfoliating powder (rice or coffee) was added gradually while whisking to avoid lumps and ensure homogeneous dispersion of particles.

Step 5: Packaging

Once the cream reached room temperature (approximately 25°C), it was transferred into sterilized jars using a silicone spatula. The jar was tapped lightly on the workbench to remove air bubbles. The jar was closed tightly and labeled with the date of preparation and composition.

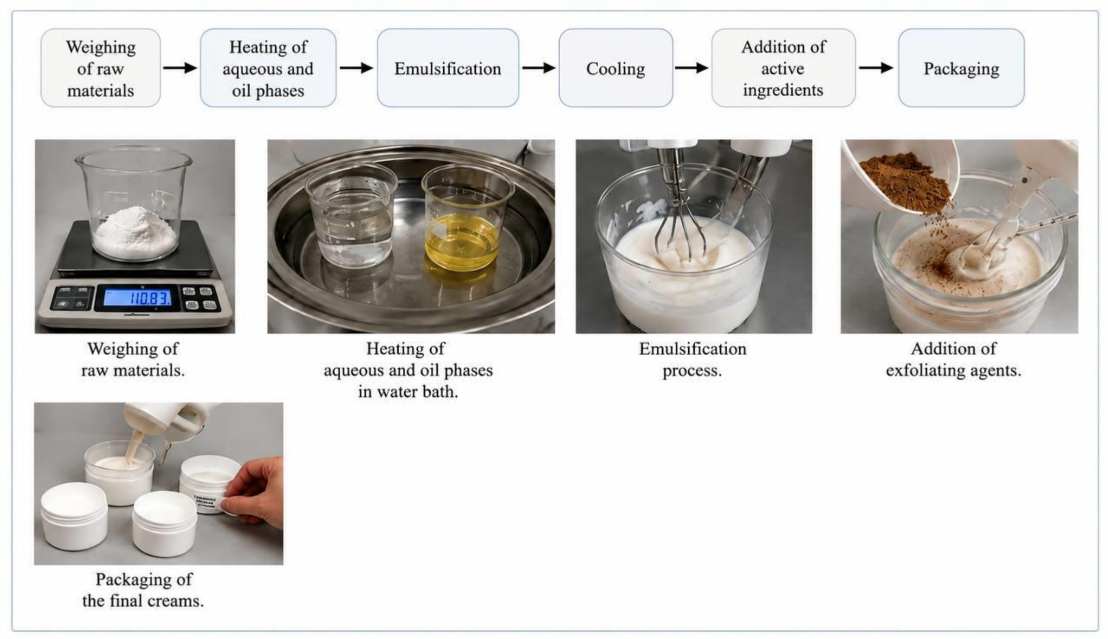


Figure II.3: Flow chart of exfoliating cream preparation

II.4. Physicochemical Characterization

The following parameters were evaluated for each formulation:

Table II .4: Physicochemical Evaluation Parameters of the Formulated Creams

Parameter	Method	Instrument	Acceptance Criteria
Appearance	Visual observation	Naked eye	Homogeneous, no phase separation
Color	Visual observation	Naked eye	Characteristic of ingredients
Odor	Olfactory evaluation	Nose	Pleasant, characteristic
Texture	Sensory evaluation	Fingertip	Smooth, creamy, homogeneous
pH	pH measurement	pH meter or pH paper	4.5 – 6.5 (skin compatible)
Spreadability	Manual application	Fingertip	Easy, uniform spreading
Stability	Temperature cycling	Refrigerator / Oven	No phase separation, no color/odor change

II.5. Stability Testing

The prepared creams were subjected to stability testing under different storage conditions:

Table II .5: Stability Testing Conditions and Evaluation Parameters

Condition	Temperature	Duration	Evaluated Parameters
Room temperature	25°C ± 2°C	28 days	Appearance, color, odor, texture, pH
Refrigeration	4°C ± 2°C	28 days	Appearance, phase separation
Heat stress (accelerated)	40°C ± 2°C	14 days	Appearance, color, odor, phase separation
Temperature cycling	4°C ↔ 40°C	3 cycles (24h each)	Stability under temperature variations

Observations were recorded at 24 hours, 48 hours, 1 week, 2 weeks, and 4 weeks.

II.6. Formulations Prepared

Three formulations were prepared in this study:

Table II .6: Formulations Prepared in the Study

Formulation Code	Exfoliating Agent	Emulsion Base
F1	Coffee grounds (8%)	O/W emulsion (same base)
F2	Rice powder (8%)	O/W emulsion (same base)
F3	Jojoba seeds powder (8%)	O/W emulsion (same base)
F4	Mixture: Coffee grounds (4%) + Rice powder (4%)	O/W emulsion (same base)

Figure II.4: Final formulation prepared

II.7. Skin Irritation Test (Safety)

A preliminary skin irritation test was conducted on the inner forearm (antecubital f

ossa) of a volunteer. A small amount of each cream was applied, and the skin was observed for 24 hours for any signs of irritation, redness, or itching. This test was performed to ensure the safety of the formulations before further evaluation.

Chapter III

Results and Discussion

III.1. Results

III.1.1. Organoleptic and Physical Properties

The physical characteristics of the four formulated exfoliating creams (F1, F2, F3, and F4) were evaluated immediately after preparation. Observations were recorded for color, odor, texture, homogeneity, and spreadability. The results are summarized in Table III.1.

Table III.1: Organoleptic and Physical Characteristics of the Formulated Creams

Formulation Code	Color	Odor	Texture / Skin Feel	Homogeneity	Spreadability
F1 (Coffee 8%)	Dark brown	Distinct coffee scent	Coarse / Granular	Homogeneous	Excellent
F2 (Rice 8%)	Creamy white	Odorless / Neutral	Fine / Smooth	Homogeneous	Excellent
F3 (Jojoba 8%)	Light beige	Mild characteristic scent	Coarse / Micro-granular	Homogeneous	Good
F4 (Mixture 4%+4%)	Light brown	Soft natural blend scent	Balanced / Semi-granular	Homogeneous	Good

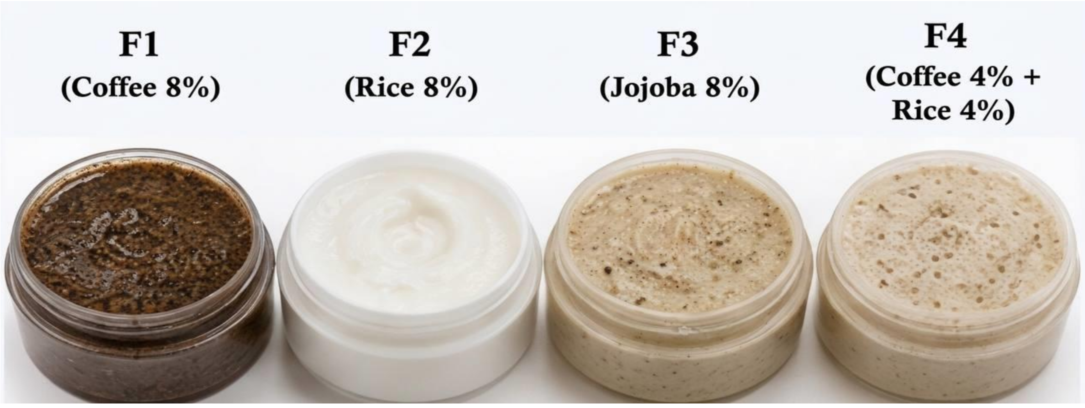


Figure III.1: Visual appearance of formulations

III .1.2. pH Measurement Results

The pH values of all formulations were measured at room temperature (25°C ± 2°C) using calibrated pH paper. Each measurement was performed in triplicate, and the average values are presented in Table III .2.

Table III .2: pH Values of the Formulated Exfoliating Creams (F1, F2, F3, and F4)

Formulation Code	Exfoliating Agent Incorporated	pH Value
F1	Coffee grounds (8%)	5.0
F2	Rice powder (8%)	5.0
F3	Jojoba seeds powder (8%)	5.8
F4	Mixture (Coffee 4% + Rice 4%)	4.9
Commercial exfoliating cream	Commercial exfoliating cream	6.7

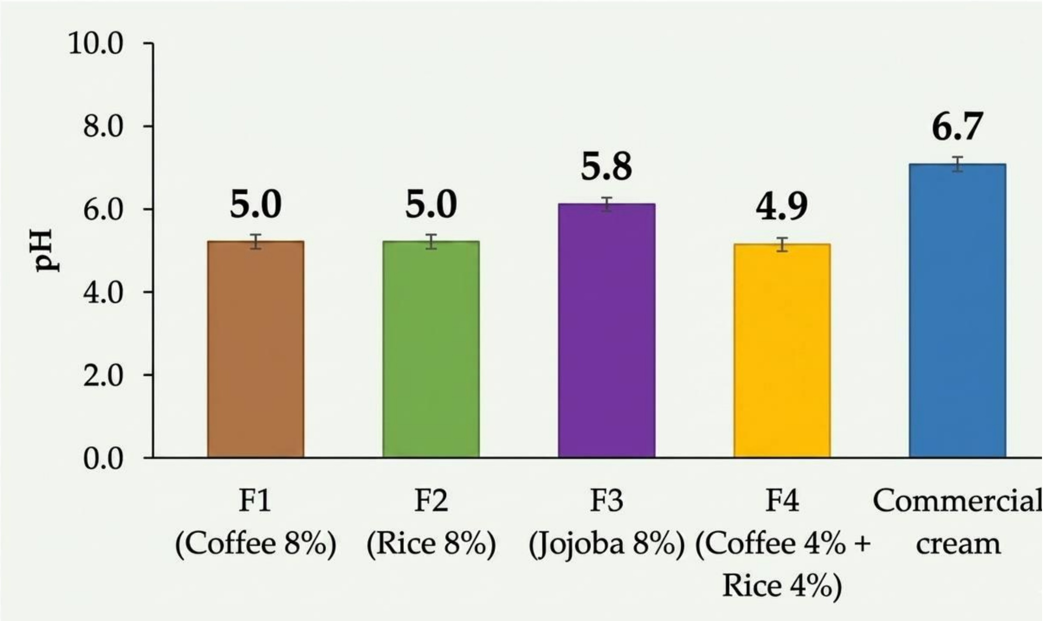


Figure III.2:PH values of formulations

III .1.3. Stability Testing Results

The formulated creams were subjected to stability testing under three different storage conditions: room temperature (25°C ± 2°C), refrigeration (4°C ± 2°C), and heat stress (40°C ± 2°C). Observations were recorded at 24 hours, 48 hours, 1 week, 2 weeks, and 4 weeks.

The results are presented in Table III .3.

Table III .3: Stability Observations of Formulated Creams Under Different Storage Conditions

Formulation	Condition	24H	48H	1week	2week	4week
F1	25°C	Stable	Stable	Stable	Stable	Stable
	4°C	Stable	Stable	Stable	Stable	Stable
	40°C	Stable	Stable	Slight oil separation	Separation increased	Phase separation
F2	25°C	Stable	Stable	Stable	Sstable	Sstable
	4°C	Stable	Stable	Stable	Stable	Stable
	40°C	Stable	Stable	Stable	Stable	Stable
F3	25°C	Stable	Stable	Stable	Slight thickening	Stable
	4°C	Stable	Stable	Stable	Stable	Stable
	40°C	Stable	Stable	Stable	Stable	Slight softening
F4	25°C	Stable	Stable	Stable	Stable	Stable
	4°C	Stable	Stable	Stable	Stable	Stable
	40°C	Stable	Stable	Stable	Slight separation	Phase separation

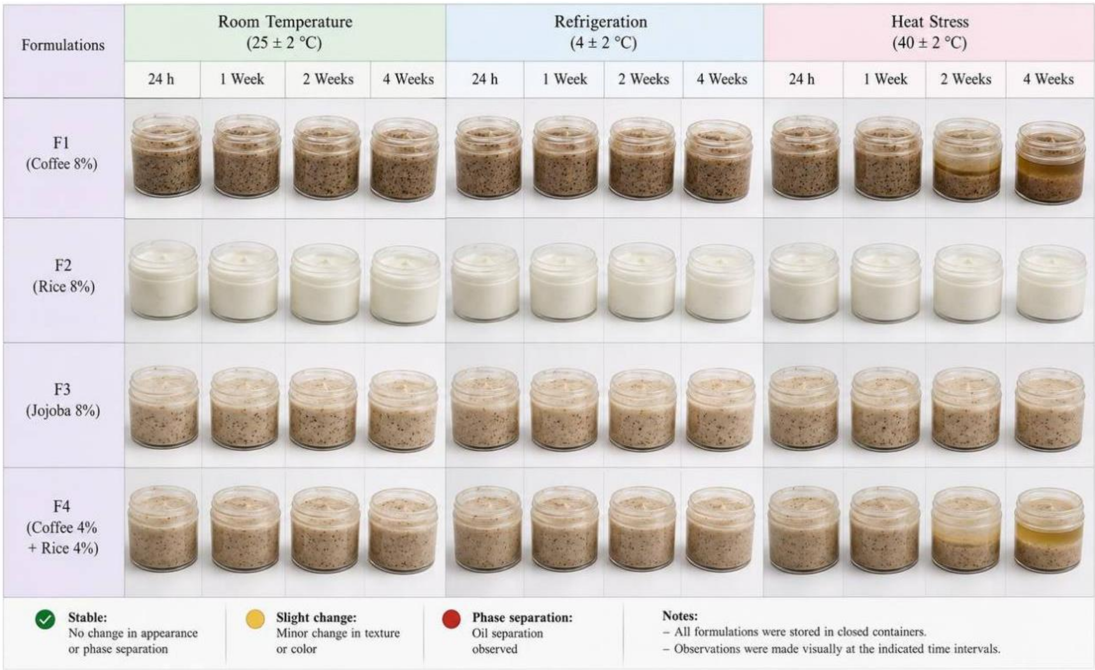


Figure III.3: Stability testing of formulated creams under different storage conditions

III .1.4. Skin Irritation Test Results

A preliminary skin irritation test was conducted on the inner forearm of a volunteer. A small amount of each cream was applied, and the skin was observed for 24 hours. The results are presented in Table III.4.

Table III.4: Skin Irritation Test Results (Preliminary)

Formulation Code	After 30 minutes	After 2 hours	After 24 hours
F1	No irritation	No irritation	No irritation
F2	No irritation	No irritation	No irritation
F3	No irritation	No irritation	No irritation
F4	No irritation	No irritation	No irritation

No signs of redness, itching, or swelling were observed for any formulation.

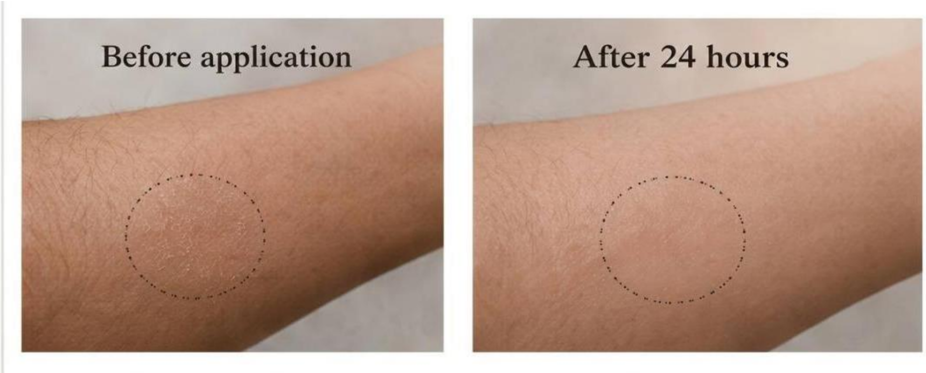


Figure III.4: Skin irritation test results

III .1.5. Antimicrobial Activity Results (Agar Diffusion Method)

The antimicrobial activity of the natural exfoliating creams was evaluated against the Venus reference cream using the agar diffusion method. Three microbial strains were tested:

- Pseudomonas aeruginosa
- Staphylococcus aureus
- Candida albicans

Two samples were tested:

- **Sample A:** Natural rice-based exfoliating cream (F2)
- **Sample B:** commercial exfoliating cream (reference)

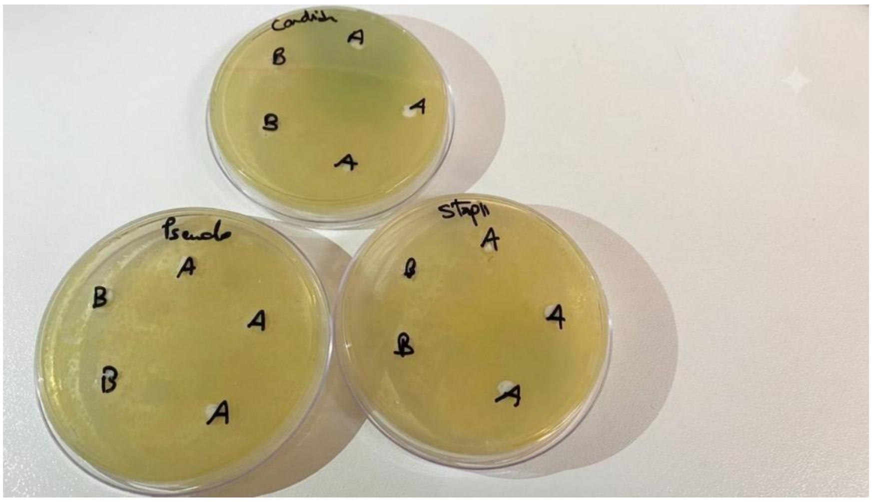


Figure III.5: Inhibition zones of Sample A and Sample B noninst the tested microgronnisms

The presence of inhibition zones (clear halos around the sample) indicates antimicrobial activity. The diameters of inhibition zones were measured in centimeters (cm). The results are presented in Table III .5.

Table III .5: Inhibition Zone Diameters (cm) for Sample A and Sample B

Microbial Strain	Sample A (Rice Cream - F2)	Sample B (Venus Cream)
Pseudomonas aeruginosa	0 cm (No inhibition zone)	1.4 cm
Staphylococcus aureus	0 cm (No inhibition zone)	1.3 cm
Candida albicans	0 cm (No inhibition zone)	1.3 cm

Observations:

- **Sample A (Natural rice cream F2):** No inhibition zones were observed around any of the three microbial strains. This indicates that the natural rice-based formulation does not possess intrinsic antimicrobial activity against the tested microorganisms.
- **Sample B (Commercial exfoliating cream):** Clear inhibition zones were observed around all three microbial strains, with diameters of 1.4 cm for Pseudomonas aeruginosa, 1.3 cm for Staphylococcus aureus, and 1.3 cm for Candida albicans. This indicates that the commercial cream contains active antimicrobial agents.

III .1.6. Viscosity Measurement Results

The viscosity of the three formulated creams was measured using a rotational viscometer at different rotational speeds (1 to 250 tr/min). The measurements were performed at a constant temperature (approximately 20-22°C) for 80 seconds per measurement point. Three formulations were tested:

- F2 (Rice cream 8%) – Table 3.6

- F1 (Coffee cream 8%) – Table 3.7
- F4 (Mixture: Coffee 4% + Rice 4%) – Table 3.8

The results are presented in Tables III .6, III .7, and III.8, and graphically illustrated in Figure III.6.

Table III .6: Viscosity Results of F2 (Rice Cream 8%)

Vitesse (tr/min)	Viscosité (Pa.s)	Viscosité (mPa.s)	Contrainte (mPa)	Couple (mN.m)	Température (°C)	Temps (s)
1	215,86	215860	215413	0.113	18.8	80
2	124,19	124190	247955	0.131	19.4	80
5	58,92	58920	294172	0.155	20.5	80
10	38,35	38350	383134	0.202	21.0	80
20	25,69	25690	512904	0.270	21.3	80
30	17,64	17640	528084	0.278	21.5	80
50	12,14	12140	605522	0.319	21.7	80
80	7,77	7770	621502	0.327	21.6	80
150	5.13	5130	768449	0.404	21.9	80
250	3.44	3440	845304	0.445	22.1	80

Table III .7: Viscosity Results of F1 (coffee Cream 8%)

Vitesse (tr/min)	Viscosité (Pa.s)	Viscosité (mPa.s)	Contrainte (mPa)	Couple (mN.m)	Température (°C)	Temps (s)
1	133,05	133050	132259	0.070	17	80
2	97,56	97560	195347	0.103	17.8	80
5	45,15	45150	225953	0.119	18.4	80
10	28,62	28620	286060	0.151	18.8	80
20	17,69	17690	353234	0.186	19.3	80
30	13	13000	389833	0.205	19.6	80
50	8,7	8700	414601	0.218	20	80
80	6,42	6420	513242	0.270	20.3	80
150	4,32	4320	647499	0.341	20.5	80
250	3,21	3210	801422	0.422	20.8	80

Table III .8: Viscosity Results of F4 (Mixture: Coffee 4% + Rice 4%)

Vitesse (trmin)	**Viscosité (Pa.s)**	**Viscosité (mPa.s)**	**Contrainte (mPa)**	**Couple (mN.m)**	**Température (°C)**	**Temps (s)**
1	260,3	260300	259479	0.137	17.7	80
2	133,17	133170	266209	0.140	20.3	80
5	69,97	69970	349362	0.184	20.7	80
10	51,72	51720	516930	0.272	20.9	80

20	35,22	35220	703180	0.370	21.3	80
30	26,38	26380	790267	0.416	21.5	80
50	17,46	17460	872499	0.459	21.6	80
80	12,08	12080	965240	0.508	21.5	80
150	8,47	8470	1266112	0.666	21.7	80
250	5,2	5200	1302833	0.686	21.9	80

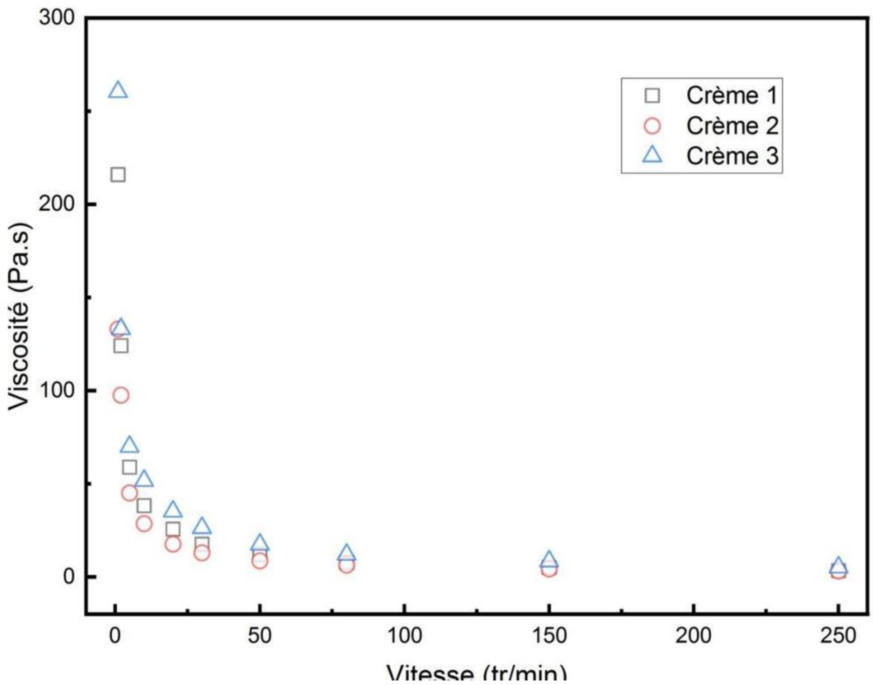


Figure III .6: Viscosity as a function of rotational speed for the three formulated creams (F1: Coffee, F2: Rice, F4: Mixture)

Calculations:

The shear-thinning behavior of the three formulations was quantified by calculating the viscosity reduction ratio and the percentage decrease in viscosity between 1 tr/min and 250 tr/min using the following formulas:

- **Shear-Thinning Ratio = Viscosity at 1 tr/min ÷ Viscosity at 250 tr/min**

- **Viscosity Decrease (%) = [(Viscosity at 1 tr/min - Viscosity at 250 tr/min) ÷ Viscosity at 1 tr/min] × 100**

The calculated parameters are presented in Table III .9.

Table III .9: Shear-Thinning Parameters of the Formulated Creams

Formulation	Viscosity at 1 tr/min (mPa.s)	Viscosity at 250 tr/min (mPa.s)	Shear-Thinning Ratio	Viscosity Decrease (%)
F1 (Coffee)	133,050	3,210	133,050 ÷ 3,210 = 41.4	[(133,050 - 3,210) ÷ 133,050] × 100 = 97.6%
F2 (Rice)	215,860	3,440	215,860 ÷ 3,440 = 62.8	[(215,860 - 3,440) ÷ 215,860] × 100 = 98.4%
F4 (Mixture)	260,300	5,200	260,300 ÷ 5,200 = 50.1	[(260,300 - 5,200) ÷ 260,300] × 100 = 98.0%

III.1.7. MEB Analysis Results

III.1.7 .1. Coffee Grounds

The morphology and elemental composition of coffee grounds were analyzed using SEM-EDS at CRAPC-Ouargla.

Surface Morphology

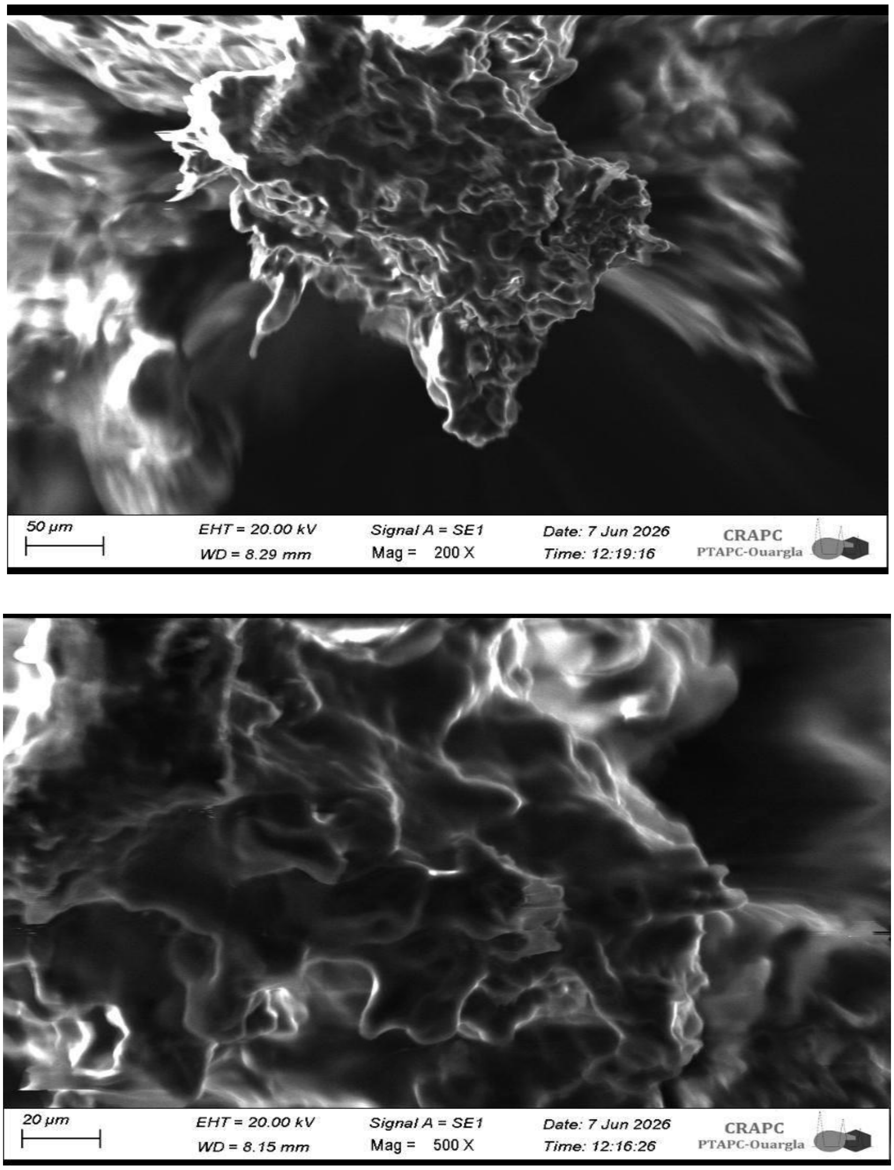


Figure III.7: SEM micrographs of coffee grounds at 200× (left) and 500× (right) magnification

Observations:

The coffee grounds exhibit an irregular, angular, and porous surface morphology. Particle sizes range approximately from 10 µm to 50 µm.

Elemental Composition

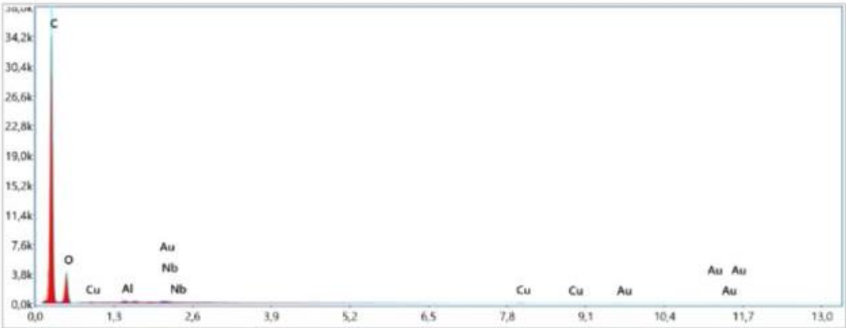


Figure III.8: EDX spectrum of coffee grounds

Table III.10: Elemental composition of coffee grounds

Element	Mass (%)	Atomic (%)
Carbon (C)	73.68	80.68
Oxygen (O)	22.97	18.88
Gold (Au)	2.49	0.17
Others (Al, Cu, Nb)	0.85	0.28

Interpretation:

Coffee grounds are primarily composed of carbon and oxygen (96.65%) , which is typical for organic plant material. The presence of gold (Au) is from the sample coating for SEM analysis and is not originally present in the coffee. Trace amounts of Al, Cu, and Nb are negligible and do not affect safety.

III.1.7. 2. Rice Powder

The morphology and elemental composition of rice powder were analyzed using SEM-EDS at CRAPC-Ouargla.

Surface Morphology

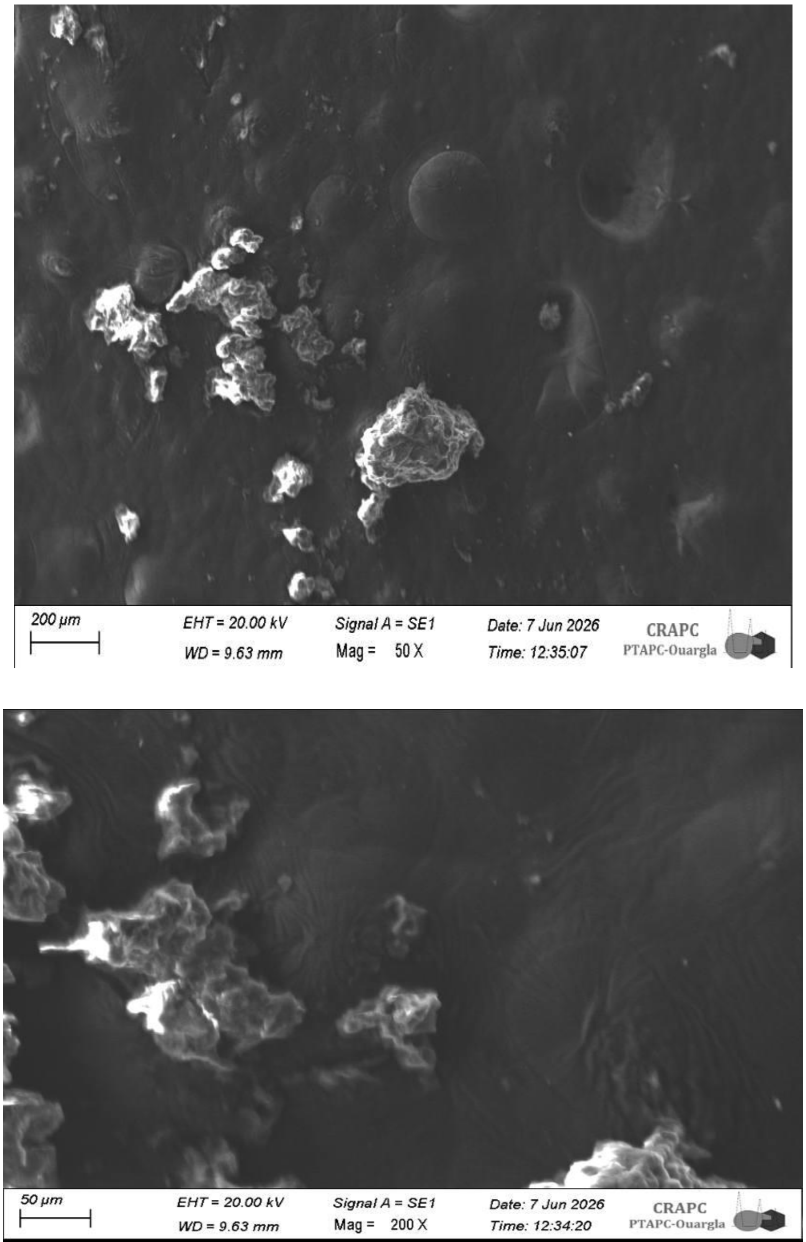
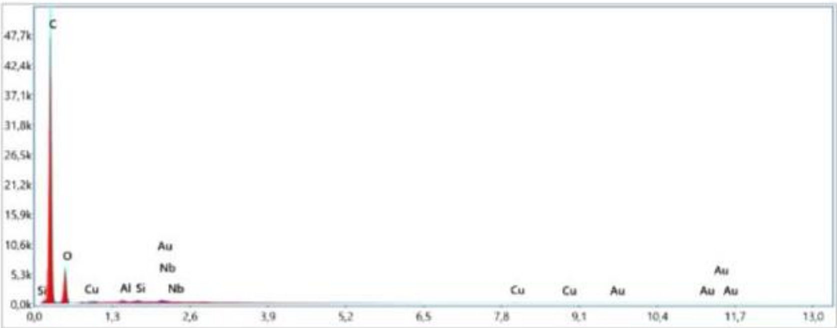


Figure III.9: SEM micrographs of rice powder at 50× (left) and 200× (right) magnification

Observations:

The rice powder exhibits irregular, angular, and fragmented particles with visible sharp edges. The particles show a heterogeneous size distribution, ranging approximately from 20 µm to over 100 µm. Unlike coffee, rice particles do not show a porous surface.

Elemental Composition



Résultats quantitatifs intelligents

Elément	% de masse	% atomique	Kratio	Z	A	F
C K	71.97	79.13	0,4913	1.0210	0.6685	1.0000
O K	24.59	20.30	0,0338	0.9759	0.1408	1.0000
AlK	0.44	0.22	0,0029	0.8667	0.7579	1.0024
SiK	0.23	0.11	0,0017	0.8856	0.8623	1.0039
NbL	0.19	0.03	0,0015	0.6846	1.1877	0.9996
CuK	0.31	0.07	0,0033	0.7122	1.0172	1.4511
AuL	2.26	0.15	0,0122	0.4960	1.0501	1.0327

Figure III.10: EDX spectrum of rice powder

Table III.11: Elemental composition of rice powder

Element	Mass (%)	Atomic (%)
Carbon (C)	71.97	79.13
Oxygen (O)	24.59	20.30
Gold (Au)	2.26	0.15
Others (Al, Si, Cu, Nb)	1.17	0.43

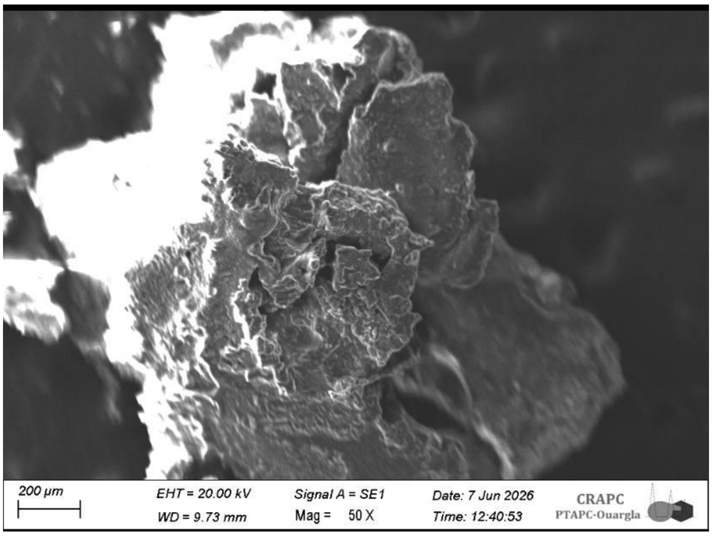
Interpretation:

Rice powder is primarily composed of carbon and oxygen (96.56%) , which is typical for organic plant material (starch, cellulose, and proteins). The presence of gold (Au) is from the sample coating for SEM analysis. Trace amounts of Al, Si, Cu, and Nb are negligible and do not affect safety. The presence of silicon (Si) may be from soil residues during rice cultivation.

III.1.7. 3.Mixture (Coffee + Rice Powder)

The morphology of the mixture (coffee + rice powder) was analyzed using SEM at CRAPC-Ouargla. (EDX analysis was not performed separately as the composition is already known from individual analyses).

Surface Morphology



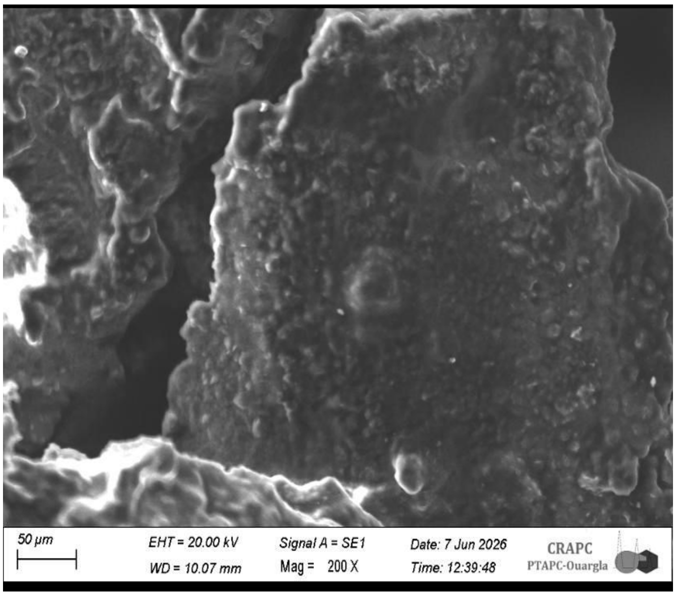


Figure III.11: SEM micrographs of the mixture (Coffee + Rice) at 50× (left) and 200× (right) magnification

Observations:

TableIII.12: The SEM micrographs of the mixture reveal the presence of two distinct particle types

Particle Type	Characteristics
Coffee particles	Irregular, angular, porous surface, darker in appearance
Rice particles	Irregular, angular, fragmented, smoother surface

The two particle types are intermingled throughout the sample. Coffee particles appear generally smaller (10-50 µm) compared to rice particles (20-100 µm). The mixture shows a heterogeneous distribution of both particle types.

III.1.7. 4. Jojoba Seeds Powder

The morphology and elemental composition of jojoba seeds powder were analyzed using SEM-EDS at CRAPC-Ouargla.

Surface Morphology

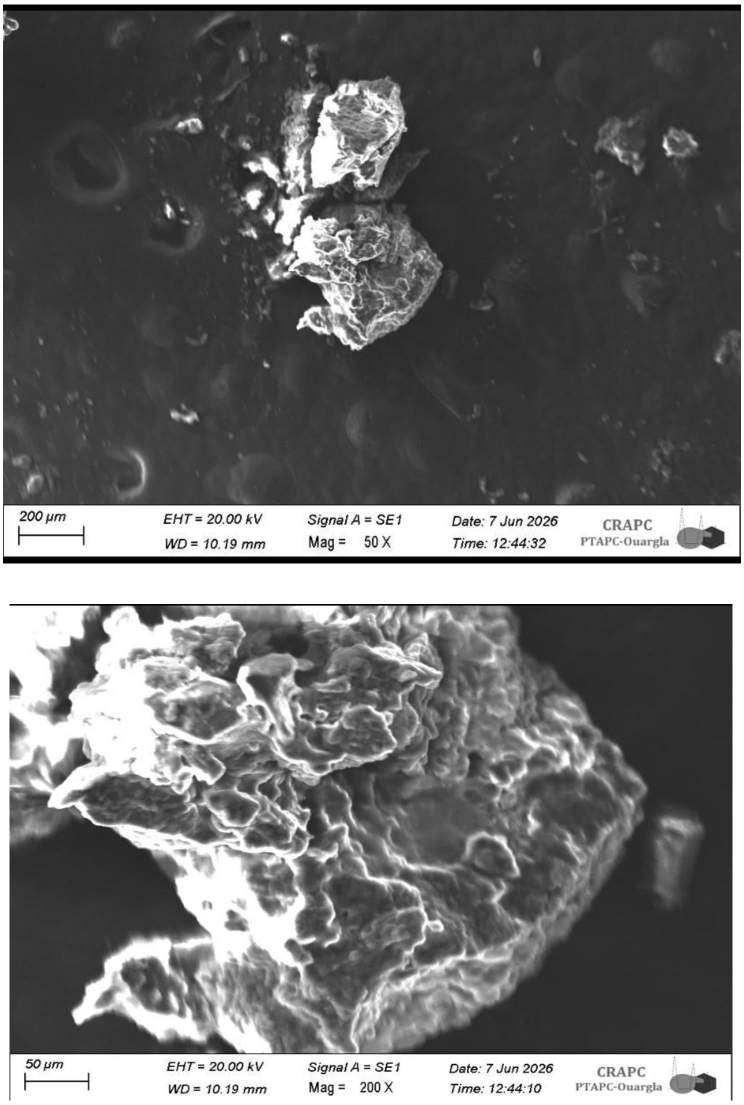


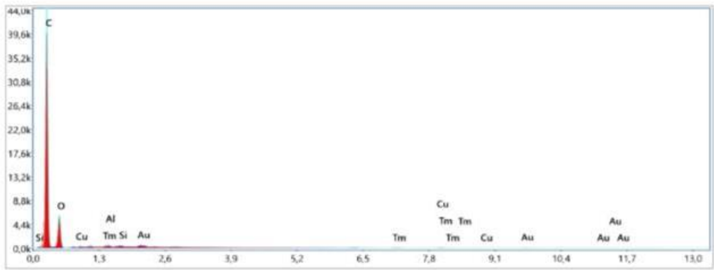
Figure III.12: SEM micrographs of jojoba powder at 50× (left) and 200× (right) magnification

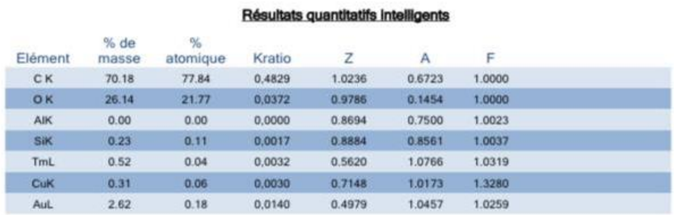
Observations:

The jojoba powder exhibits irregular, angular, and fragmented particles with a smooth surface texture (non-porous). The particle size distribution is heterogeneous, ranging approximately from 20 µm to over 150 µm.

Unlike coffee particles which are porous, jojoba particles appear dense and compact with a smooth surface.

Elemental Composition





Résultats quantitatifs intelligents

Elément	% de masse	% atomique	Kratio	Z	A	F
C K	70.18	77.84	0,4829	1.0236	0.6723	1.0000
O K	26.14	21.77	0,0372	0.9786	0.1454	1.0000
AlK	0.00	0.00	0,0000	0.8694	0.7500	1.0023
SiK	0.23	0.11	0,0017	0.8884	0.8561	1.0037
TmL	0.52	0.04	0,0032	0.5620	1.0766	1.0319
CuK	0.31	0.06	0,0030	0.7148	1.0173	1.3280
AuL	2.62	0.18	0,0140	0.4979	1.0457	1.0259

Figure III.13: EDX spectrum of jojoba powder

Table III.13: Elemental composition of jojoba powder

Element	Mass (%)	Atomic (%)
Carbon (C)	70.18	77.84
Oxygen (O)	26.14	21.77
Gold (Au)	2.62	0.18
Others (Si, Cu, Tm)	1.06	0.21

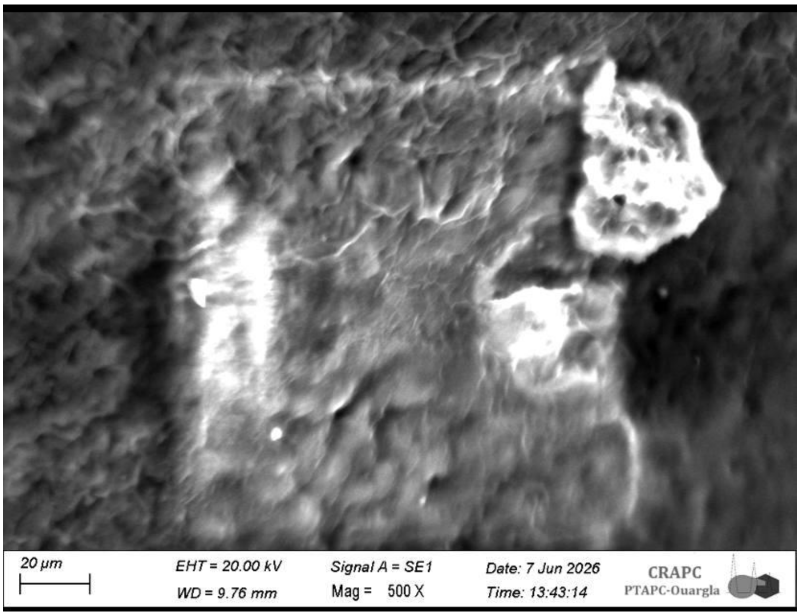
Interpretation:

Jojoba powder is primarily composed of carbon and oxygen (96.32%), which is typical for organic plant material (wax esters, fatty acids, and oils). The presence of gold (Au) is from the sample coating for SEM analysis. Trace amounts of Si, Cu, and Tm are negligible and do not affect safety.

Commercial Cream

The morphology of the commercial exfoliating cream (Venus) was analyzed using SEM at CRAPC-Ouargla.

Surface Morphology



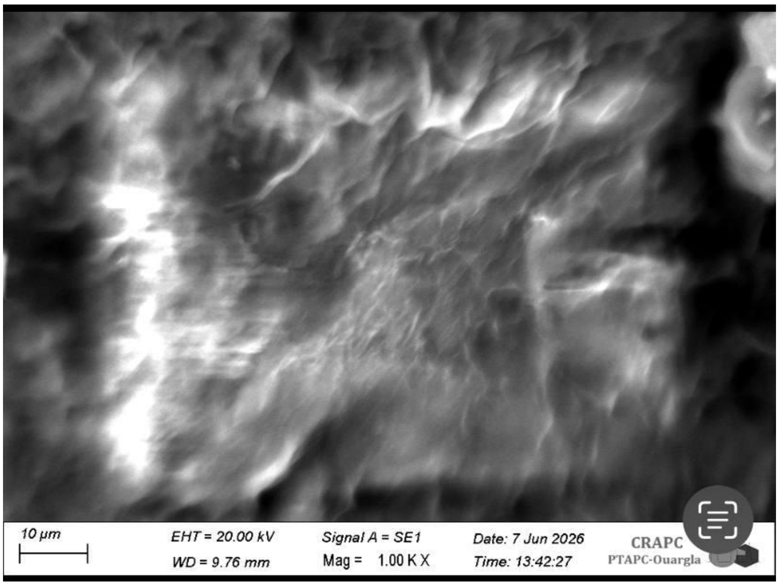


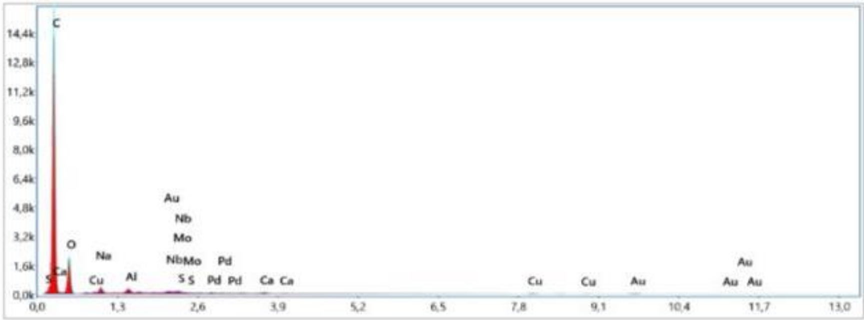
Figure III.14: SEM micrographs of commercial cream at different magnifications: (a) 1.00 KX (10 µm), (b) 500× (20 µm), (c) 250× (40 µm)

Observations:

The SEM micrographs of the Venus cream reveal a smooth and homogeneous matrix with evenly distributed exfoliating particles. The particles appear to be well incorporated into the emulsion without visible agglomeration or phase separation.

The particle morphology appears more uniform and rounded compared to the natural exfoliants (coffee, rice, jojoba), suggesting the use of synthetic or processed exfoliating agents.

Elemental Composition



Résultats quantitatifs intelligents

Elément	% de masse	% atomique	Kratio	Z	A	F
C K	68.91	78.71	0,4308	1.0338	0.6047	1.0000
O K	22.59	19.37	0,0318	0.9890	0.1423	1.0000
NaK	1.54	0.92	0,0059	0.8981	0.4276	1.0005
AlK	0.69	0.35	0,0045	0.8796	0.7346	1.0019
NbL	0.20	0.03	0,0016	0.6951	1.1616	0.9999
MoL	0.56	0.08	0,0044	0.6874	1.1425	1.0000
S K	0.00	0.00	0,0000	0.8804	0.9331	1.0081
PdL	0.25	0.03	0,0019	0.6705	1.1455	1.0008
CaK	0.27	0.09	0,0024	0.8488	1.0007	1.0312
CuK	0.46	0.10	0,0046	0.7244	1.0153	1.3654
AuL	4.50	0.31	0,0243	0.5050	1.0461	1.0199

Figure III.15: EDX spectrum of Venus commercial cream

Table III.14: Elemental composition of commercial cream

Element	Mass (%)	Atomic (%)
Carbon (C)	68.91	78.71
Oxygen (O)	22.59	19.37
Gold (Au)	4.50	0.31

Sodium (Na)	1.54	0.92
Others (Al, Nb, Mo, Pd, Ca, Cu)	2.46	0.69

Interpretation:

The Venus cream is primarily composed of carbon and oxygen (91.5%), which is typical for cosmetic emulsions containing organic ingredients. The presence of sodium (Na) (1.54%) may indicate the presence of salts or emulsifying agents. Trace amounts of other elements (Al, Nb, Mo, Pd, Ca, Cu) are likely from pigments, preservatives, or trace contaminants.

The gold (Au) is from the sample coating for SEM analysis

III.2 Discussion

III.2.1 Discussion of Organoleptic and Physical Properties

When the four formulations were examined, some differences were observed in terms of color, odor, and texture. However, all formulations were homogeneous and spread easily. The dark brown color and characteristic coffee scent of F1 were directly due to the natural color and odor of the coffee grounds. F2 was white and creamy, and it felt smoother because the rice powder particles were very fine. F3 was light beige and felt slightly rough due to the jojoba seed particles. F4 was intermediate in appearance and texture because it contained a mixture of coffee and rice powders.

The differences in texture can be explained by the shape and size of the exfoliating particles. Rice powder particles are smaller and more uniform, which results in a smoother feel. Even though the textures varied, all formulations were homogeneous and spread easily, indicating that the exfoliating particles were well incorporated into the emulsion base.

These observations are similar to those reported by (Rezarta Shkreli, 2022), who stated that particle size and distribution can significantly affect the sensory properties of cosmetic products without necessarily compromising product quality.

III.2.2. Discussion of pH Comparison with commercial exfoliating Cream

The pH values of the formulated creams ranged between 4.9 and 5.8. This range is compatible with the physiological pH of healthy human skin, which is typically between 4.5 and 6.0. Maintaining the skin's slightly acidic pH is essential for preserving the protective acid mantle and preventing irritation. Therefore, all formulations are considered suitable for topical application.

F1 (coffee) and F2 (rice) exhibited identical pH values of 5.0. F3 (jojoba) showed a slightly higher pH of 5.8, which can be explained by the neutral nature of jojoba wax esters. F4 (mixture) recorded the lowest pH value of 4.9, which may be attributed to the combined organic acids present in both coffee and rice powders, such as chlorogenic acid and ferulic acid.

Comparison with Venus commercial cream:

The Venus reference cream recorded a pH value of 6.7. When compared with the natural formulations (pH 4.9-5.8), the Venus cream is less acidic. While a pH of 6.7 is still within the acceptable range for cosmetic products, it is higher than the ideal physiological pH of skin (4.5-6.0). The natural formulations, particularly F2 (pH 5.0) and F4 (pH 4.9), are closer to the skin's natural pH, which may offer better skin compatibility and a lower risk of disrupting the acid mantle.

These results indicate that the natural formulations are as suitable, if not more suitable, for topical application compared to the commercial product. As reported by (Proksch, 2018), cosmetic products formulated with a pH similar to that of the skin are less likely to cause irritation or disrupt the skin barrier function.

The pH values of the formulated creams (F1-F4) were compared with the Venus commercial exfoliating cream. Venus is an Algerian cosmetic brand founded in 1981 that has become a reference in the Algerian market, with products now exported internationally including to France. Venus produces a range of exfoliating products, including the Venus Apricot Face & Body Scrub Cream, which contains natural exfoliants.

All four natural formulations exhibited pH values (4.9-5.8) that are compatible with the physiological pH of human skin. When compared with the Venus reference cream, the natural formulations showed comparable pH values. This indicates that the developed natural creams are as suitable for topical application as the commercial product, without risk of disrupting the skin's acid mantle.

The slightly lower pH of F4 (4.9) may offer enhanced exfoliating efficacy compared to the other formulations and possibly the Venus cream, depending on the commercial product's pH value.

III.2.3. Discussion of Stability Results

The stability study revealed that F2 (rice cream) was the most stable formulation under all storage conditions. No changes in appearance, texture, odor, or phase separation were observed during the entire 4-week test period. The excellent stability of F2 can be explained by the fine particle size of rice powder and its uniform distribution throughout the emulsion, which helped maintain the structural integrity of the formulation.

In contrast, F1 (coffee) and F4 (mixture) exhibited phase separation when exposed to high temperature (40°C). This reduced stability can be explained by the following factors. At elevated temperatures, the emulsion viscosity decreases, allowing oil droplets to move more easily, coalesce, and separate from the aqueous phase. Additionally, the irregular and angular shape of coffee particles may have physically disrupted the oil-water interface, accelerating phase separation. The mixture formulation F4 may have been further destabilized by the combination of particles with different densities and surface properties.

F3 (jojoba) was mostly stable, although it became slightly softer when heated, without complete phase separation.

These results are consistent with the findings of (Rezarta Shkreli, 2022), who demonstrated that temperature and particle characteristics significantly influence the stability of cosmetic emulsions.

III.2.4. Discussion of Skin Irritation Results

The preliminary skin irritation test revealed no signs of redness, itching, or swelling for any of the four formulations. This confirms that all natural exfoliants (coffee, rice, and jojoba) are safe for topical application at the concentrations used (8% or 4% each). The O/W emulsion base, containing Olivem 1000, sweet almond oil, shea butter, and beeswax, was non-irritating and well-tolerated by the skin. The preservative system (Cosgard at 0.8%) also did not cause any adverse reaction.

It should be noted that this was a preliminary test conducted on a single volunteer. More extensive testing on a larger sample size would be required for definitive safety conclusions.

III.2.5. Discussion of Antimicrobial Activity Results and Comparison With commercial Cream

The antimicrobial activity of the natural rice-based cream (Sample A = F2) was compared with the Venus commercial cream (Sample B) using the agar diffusion method against three microbial strains: Pseudomonas aeruginosa, Staphylococcus aureus, and Candida albicans.

III.2.5. 1.Results for Venus cream (Sample B):

The Venus cream showed clear inhibition zones around all three microbial strains, with diameters of 1.4 cm against Pseudomonas aeruginosa, 1.3 cm against Staphylococcus aureus, and 1.3 cm against Candida albicans. These results indicate that the Venus cream contains active ingredients with broad-spectrum antimicrobial properties. These active agents could be synthetic preservatives (such as parabens, phenoxyethanol, or benzoic acid derivatives) or other antimicrobial compounds.

III.2.5. 2. Results for natural rice cream (Sample A = F2):

In contrast, the natural rice cream (F2) showed no inhibition zones (0 cm) against any of the three tested microorganisms. This indicates that the rice-based formulation does not possess intrinsic diffusible antimicrobial activity. This result can be explained by the following factors:

. Nature of the preservative used: The natural formulation contains Cosgard (0.8%) as a preservative. Cosgard is a broad-spectrum preservative containing benzyl alcohol, salicylic acid, glycerin, and sorbic acid. It is Ecocert-approved for organic cosmetics and is designed to prevent microbial growth within the product during storage. However, in the agar diffusion test, Cosgard may not diffuse sufficiently through the agar medium to create measurable inhibition zones.

. Composition of rice powder: Rice powder is primarily composed of starch, proteins, and ferulic acid. While ferulic acid has antioxidant properties, its antimicrobial activity is relatively weak compared to synthetic agents.

III.2.5. 3. Important distinction:

The absence of inhibition zones does not mean that the natural cream is unsafe or contaminated. It simply means that the formulation relies on in-container preservation rather than diffusible antimicrobial agents. The natural cream remains safe for use as long as it is properly preserved (Cosgard at 0.8%), manufactured under hygienic conditions, and passes standard preservative efficacy tests.

Comparison between natural and commercial creams:

Table III.15: Comparison between natural and commercial creams

Parameter	Natural Rice Cream (F2)	Venus Commercial Cream
Inhibition zones	0 cm	1.3 - 1.4 cm
Preservation strategy	In-container (Cosgard)	Diffusible antimicrobial agents

Natural origin	100% natural	Contains synthetic preservatives
Skin irritation risk	Very low	Possible with sensitive skin

The Venus cream's strong antimicrobial activity suggests that it contains potent antimicrobial agents that are highly diffusible in agar. While this provides additional protection against contamination, it may also increase the risk of skin irritation or allergic reactions in sensitive individuals, depending on the nature and concentration of these agents.

The natural rice cream, while lacking diffusible antimicrobial activity, remains safe for use due to its effective in-container preservative system (Cosgard) and is more suitable for consumers seeking natural, eco-friendly products.

III.2.6. Discussion of Viscosity Results

The viscosity measurements revealed that all three formulations (F1, F2, and F4) exhibit shear-thinning behavior, where the apparent viscosity decreases significantly as the rotational speed increases. This is clearly demonstrated in Figure 3.2, where the viscosity values drop sharply from low speeds (1 tr/min) to high speeds (250 tr/min) for all creams.

This behavior is characteristic of cosmetic emulsions and is highly desirable for topical products. At rest or during storage (low shear rate), the cream maintains a high viscosity, which ensures physical stability and prevents phase separation. During application on the skin (high shear rate), the viscosity decreases, allowing the cream to spread easily and uniformly.

Quantitative analysis:

- **F2 (Rice cream):** Viscosity decreased from 215,860 mPa.s to 3,440 mPa.s (reduction of 98.4%)

- **F1 (Coffee cream):** Viscosity decreased from 133,050 mPa.s to 3,210 mPa.s (reduction of 97.6%)
- **F4 (Mixture):** Viscosity decreased from 260,300 mPa.s to 5,200 mPa.s (reduction of 98.0%)

Comparison between formulations:

At low shear rates, F4 (mixture) exhibited the highest viscosity (260,300 mPa.s), followed by F2 (rice) (215,860 mPa.s), and finally F1 (coffee) (133,050 mPa.s). This indicates that the mixture of coffee and rice particles creates a more structured network within the emulsion. At high shear rates, all three formulations reached comparable viscosity values (3,200-5,200 mPa.s), confirming that all creams are easily spreadable upon application.

The higher viscosity of F2 compared to F1 can be explained by the finer particle size and more uniform distribution of rice powder. The lower viscosity of F1 may be attributed to the irregular, angular shape of coffee particles, which disrupt the internal network more easily.

These findings are consistent with Mägeruşan et al. (2023), who reported that particle characteristics significantly affect the rheological properties of cosmetic emulsions.

III.2.7. Overall Comparative Summary

Table III .16: Comparative Summary of the Four Formulations

Parameter	F1 (Coffee)	F2 (Rice)	F3 (Jojoba)	F4 (Mixture)
Color	Dark brown	Creamy white	Light beige	Light brown
Texture	Coarse	Smooth	Slightly rough	Semi-smooth
PH	5.0	5.0	5.8	4.9
Stability at 40°C	Poor	Excellent	Good	Poor
Skin irritation	None	None	None	None
Viscosity at 1 tr/min (mPa.s)	133,050	215,860	Not tested	260,300
Viscosity decrease (%)	97.6%	98.4%	Not tested	98.0%

Table III.17: Comparative Summary of Natural Rice Cream (F2) versus Commercial Cream

Parameter	Natural Rice Cream (F2)	Commercial Cream
PH	5.0	6.7
Stability at 40°C	Stable	Not tested
Skin irritation	Not irritation	Not tested
Antimicrobial activity (inhibition zones)	0 cm	1.3 - 1.4 cm
Preservation strategy	In-container (Cosgard)	Diffusible agents

Natural origin	100% natural exfoliant	Commercial (unknown composition)

III.2.7. Discussion of MEB Results

III.2.7. 1. Coffee Grounds

The SEM analysis revealed that coffee particles have an irregular, angular, and porous morphology with sizes ranging from 10-50 µm.

Effect on exfoliation: The irregular and angular shape provides effective mechanical exfoliation by creating friction that removes dead skin cells. This explains the coarse, granular texture of F1 (coffee cream).

Effect on stability: The same irregular morphology may disrupt the oil-water interface, contributing to the phase separation observed in F1 at 40°C.

Effect on viscosity: The irregular particle shape prevents the formation of a well-organized internal network, explaining why F1 exhibited the lowest viscosity (133,050 mPa.s at 1 tr/min) compared to other formulations.

Elemental composition: The high carbon and oxygen content confirms the organic nature of coffee grounds, which contain bioactive compounds such as caffeine and chlorogenic acids known for their antioxidant properties (Érica Mendes dos Santos, 2021).

III.2.7. 2. Rice Powder

The SEM analysis revealed that rice particles have an irregular, angular, and fragmented morphology with sizes ranging from 20 µm to over 100 µm.

Effect on exfoliation: The irregular and angular shape provides effective mechanical exfoliation. However, compared to coffee, rice particles appear less porous and more compact.

Effect on stability: Despite their irregular shape, rice particles demonstrated excellent stability (F2 remained stable at all temperatures). This suggests that particle size distribution and uniform dispersion are more important than particle shape for stability.

Effect on texture: The fine particle size and uniform distribution of rice powder contributed to the smooth texture observed in F2, making it the most pleasant formulation for application.

Elemental composition: The high carbon and oxygen content confirms the organic nature of rice powder, which contains bioactive compounds such as ferulic acid and phytic acid known for their skin-brightening properties (Natalya Beldieva, 2023).

III.2.7. 3. Mixture (Coffee + Rice Powder)

The SEM analysis of the mixture revealed the presence of both coffee and rice particles with their distinct morphological characteristics.

Effect on exfoliation: The mixture combines the properties of both exfoliants. Coffee particles (porous, angular) provide effective mechanical exfoliation, while rice particles (angular, fragmented) contribute to the exfoliating action with a slightly different texture.

Effect on stability: The mixture formulation (F4) exhibited phase separation at 40°C, similar to F1 (coffee alone). This suggests that the presence of coffee particles, even at a lower concentration (4%), is sufficient to affect the thermal stability of the emulsion. The combination of particles with different sizes, shapes, and densities may have created an inhomogeneous dispersed phase, accelerating phase separation.

Effect on viscosity: The mixture exhibited the highest viscosity at low shear rates (260,300 mPa.s at 1 tr/min). This can be explained by the combination of different particle sizes and shapes (coffee: 10-50 µm porous angular + rice: 20-100 µm angular fragmented), which creates a more entangled and structured network within the emulsion, increasing internal resistance to flow at rest.

Overall assessment: While the mixture showed excellent viscosity properties at rest (good physical stability during storage), its thermal stability was compromised by the presence of coffee particles. The rice-only formulation (F2) remains the best choice for overall stability.

III.2.7. 4. Jojoba Seeds Powder

The SEM analysis revealed that jojoba particles have an irregular, angular, and fragmented morphology with a smooth, non-porous surface. Particle sizes range from 20 µm to over 150 µm.

Effect on exfoliation: The irregular and angular shape provides effective mechanical exfoliation. However, the particles are larger than coffee and rice, which may explain the coarser texture felt during application of F3.

Effect on stability: Despite their irregular shape and larger size, jojoba particles showed good stability (F3 remained mostly stable with only slight softening at 40°C). The smooth, non-porous surface of jojoba particles may be less disruptive to the emulsion interface compared to the porous coffee particles.

Effect on viscosity: Jojoba viscosity was not measured in this study, but based on particle morphology, it would likely show intermediate behavior between coffee and rice.

Elemental composition: The high carbon and oxygen content confirms the organic nature of jojoba powder, which contains wax esters similar to human sebum, providing moisturizing benefits to the skin (Hoda E. Mohamed, 2021).

III.2.7. 5.Commercial Cream

The SEM analysis of the Venus commercial cream revealed important differences compared to the natural formulations.

Comparison with natural formulations:

- Parameter Natural Creams (F1-F4) Venus Commercial Cream
- Particle morphology Irregular, angular More uniform, rounded
- Particle distribution Variable (coffee showed agglomeration) Homogeneous, well-dispersed
- Matrix appearance Variable Smooth and uniform

Interpretation:

The more uniform and rounded particle morphology of the Venus cream suggests the use of synthetic or processed exfoliating agents (such as polyethylene beads or processed natural particles). This type of particle is designed to provide effective exfoliation with a lower risk of micro-tears compared to irregular natural particles.

The smooth and homogeneous matrix indicates good emulsion stability and optimal particle dispersion, which is expected for a commercially optimized product.

Elemental composition:

The presence of sodium (Na) and other trace elements in the Venus cream reflects the use of additional additives such as:

- Emulsifiers and surfactants
- Preservatives (e.g., sodium benzoate)
- pH adjusters
- Possibly fragrances or other functional ingredients

In contrast, the natural formulations (coffee, rice, jojoba) showed only carbon, oxygen, and trace elements from natural sources or sample preparation.

Conclusion:

The commercial cream represents a commercially optimized formulation with:

- Uniform, rounded exfoliating particles
- Homogeneous particle distribution
- Additional synthetic additives (indicated by Na and other trace elements)

The natural formulations, while less uniform in particle morphology, offer the advantage of being 100% natural and biodegradable.

Table III.18: Comparative summary of particle morphology, size, elemental composition, and origin of natural exfoliants (coffee, rice, jojoba, mixture) and commercial cream (Venus) based on SEM-EDX analysis

Sample	Particle Shape	Particle Size	Key Elements	Notes
Coffee	Irregular, angular, porous	10-50 µm	C, O	Natural
Rice	Irregular, angular, fragmented	20-100 µm	C, O	Natural
Jojoba	Irregular, angular, smooth	20-150 µm	C, O	Natural
Mixture	Mixed (coffee + rice)	10-100 µm	C, O	Natural blend
(Commercial)	Uniform, rounded	Not measured	C, O, Na, others	Synthetic/processed

III.2.8. Conclusion of Discussion

- All four natural formulations (F1-F4) are skin-compatible (pH 4.9-5.8) and safe for topical application, with no signs of irritation observed.
- F2 (rice powder 8%) exhibited the best overall stability under all storage conditions, making it the most suitable natural exfoliant for stable emulsion formulations.

- All tested formulations (F1, F2, F4) exhibited excellent shear-thinning behavior, with viscosity decreases exceeding 97%, confirming their suitability for cosmetic application.
- The natural rice-based cream (F2) showed no antimicrobial activity in the agar diffusion test (0 cm), while the Venus commercial cream showed significant activity (1.3-1.4 cm). This difference reflects different preservation strategies rather than product safety issues. The natural cream relies on in-container preservation (Cosgard), while the commercial cream contains diffusible antimicrobial agents.
- The natural formulations, particularly F2 (pH 5.0) and F4 (pH 4.9), are closer to the skin's natural pH compared to the Venus cream (pH 6.7), suggesting better skin compatibility.

Reference

1. Dos Santos, É. M., de Macedo, L. M., Tundisi, L. L., Ataide, J. A., Camargo, G. A., Alves, R. C., Oliveira, M. B. P. P., & Mazzola, P. G. (2021). Coffee by-products in topical formulations: A review. Trends in Food Science & Technology, 111, 280–291. https://doi.org/10.1016/j.tifs.2021.02.064
2. Mohamed, H. E., El-Moghazy, R. A. M., El-Sayed, H. M., El-Gayed, S. H., & Al-Qurashi, A. D. (2021). Jojoba oil: An updated comprehensive review on chemistry, pharmaceutical uses, and toxicity. Polymers, 13(11), 1711. https://doi.org/10.3390/polym13111711
3. Proksch, E. (2018). pH in nature, humans and skin. The Journal of Dermatology, 45(9), 1044–1052. https://doi.org/10.1111/1346-8138.14489
4. Shkreli, R., Terziu, R., Memushaj, L., & Dhamo, K. (2022). Formulation and stability evaluation of a cosmetics emulsion loaded with different concentrations of synthetic and natural preservative. Journal of Biological Studies, 5(1), 38–51.
5. Tarasov, V., & Beldieva, N. (2023). Rice screenings as effective ingredients in beauty products. E3S Web of Conferences, 389, 03027. https://doi.org/10.1051/e3sconf/202338903027

General Conclusion

General Conclusion

In this study, four natural exfoliating creams were successfully formulated using an oil-in-water (O/W) emulsion base. The exfoliating agents used were coffee grounds (F1, 8%), rice powder (F2, 8%), jojoba seeds powder (F3, 8%), and a mixture of coffee grounds and rice powder (F4, 4% + 4%). All formulations were evaluated for their physicochemical properties, stability under different storage conditions, pH, viscosity, skin irritation, antimicrobial activity, and morphological characteristics using SEM-EDS analysis.

The main findings of this study are summarized as follows:

Regarding stability:

F2 (rice cream 8%) was the most stable formulation under all storage conditions (room temperature, refrigeration at 4°C, and heat stress at 40°C) throughout the entire 4-week test period. No changes in appearance, color, odor, texture, or phase separation were observed. In contrast, F1 (coffee) and F4 (mixture) exhibited phase separation at 40°C after two weeks, which is attributed to the irregular, angular, and porous morphology of coffee particles that disrupt the oil-water interface at elevated temperatures. F3 (jojoba) remained mostly stable with only slight softening at 40°C.

Regarding pH:

All formulations exhibited pH values within the physiological range of healthy human skin (4.5–6.0). F1 and F2 recorded pH 5.0, F3 recorded pH 5.8, and F4 recorded the lowest pH of 4.9. Compared to the Venus commercial cream (pH 6.7), all natural formulations are closer to the skin's natural pH, indicating better skin compatibility.

Regarding viscosity:

All tested formulations (F1, F2, F4) exhibited excellent shear-thinning behavior, with viscosity decreases exceeding 97% as rotational speed increased from 1 to 250 tr/min. F4 (mixture) showed the highest viscosity at low shear rates (260,300 mPa.s), followed by F2 (215,860 mPa.s) and F1 (133,050 mPa.s). This rheological behavior is highly desirable for cosmetic creams, ensuring good physical stability during storage and easy spreadability upon application.

Regarding skin safety:

The preliminary skin irritation test revealed no signs of redness, itching, or swelling for any of the four formulations, confirming that all natural exfoliants at the concentrations used are safe for topical application.

Regarding antimicrobial activity:

The natural rice-based cream (F2) showed no inhibition zones against the tested microorganisms, while the Venus commercial cream showed clear inhibition zones (1.3–1.4 cm). This difference reflects different preservation strategies rather than product safety issues. F2 relies on in-container preservation using Cosgard, which is Ecocert-approved and safe for natural cosmetics.

Regarding morphological analysis (SEM-EDX):

Coffee particles (10–50 µm) are irregular, angular, and porous. Rice particles (20–100 µm) are irregular, angular, and fragmented. Jojoba particles (20–150 µm) are irregular, angular, with a smooth non-porous surface. All natural exfoliants are composed primarily of carbon and oxygen (>96%), confirming their organic plant origin. The Venus commercial cream revealed more uniform, rounded particles with additional elements (sodium, calcium), indicating the presence of synthetic additives.

Overall conclusion:

- F2 (rice powder 8%) is the best formulation in terms of overall stability, smooth texture, skin-compatible pH, safety, and desirable cosmetic properties. It is the most suitable candidate for further development and potential commercialization.
- F4 (mixture of coffee 4% + rice 4%) showed excellent viscosity properties and a very good pH (4.9), but its poor thermal stability due to the presence of coffee particles limits its practical application. However, it remains promising for

future optimization, such as coating or encapsulating coffee particles to improve stability.

- F1 (coffee 8%) provides effective exfoliation and antioxidant potential but requires stabilization improvements for use in hot climates.
- F3 (jojoba 8%) is safe and mostly stable, making it a good option for sensitive skin, though its coarser texture may be less appealing to some users.
- Finally, this study successfully demonstrates that natural, biodegradable, and safe exfoliating creams can be formulated using agricultural by-products such as rice powder and spent coffee grounds. These findings support the growing global shift towards green cosmetics and sustainable skincare alternatives.

Future Perspectives

Based on the findings of this study, the following future perspectives are proposed:

1. Long-term stability studies: Conduct stability tests over 6 to 12 months to confirm the shelf life of the formulated creams, especially F2 (rice) and F4 (mixture).

2. In vivo efficacy evaluation: Perform clinical tests on a larger group of volunteers to evaluate the exfoliating effectiveness, skin texture improvement, and moisturizing benefits of the natural formulations.

3. Antioxidant activity assessment: Evaluate the antioxidant potential of the formulations, particularly F1 (coffee) and F2 (rice), using DPPH or FRAP assays, as these natural ingredients are rich in polyphenols and chlorogenic acids.

4. Optimization of the mixture (F4): Improve the thermal stability of the coffee-rice mixture by using coated or encapsulated coffee particles, or by reducing the particle size to minimize disruption of the emulsion interface.

5. Formulation with other natural exfoliants: Explore other agricultural by-products such as walnut shell powder, oat flour, or date seed powder as natural exfoliating agents.

6. Development of a complete skincare line: Expand the study to formulate complementary products such as natural cleansers, serums, and moisturizers containing the same bioactive ingredients.

7. Ecotoxicological assessment: Evaluate the biodegradability and environmental impact of the formulated creams to confirm their eco-friendly profile compared to synthetic exfoliants.

8. Industrial scale-up: Study the feasibility of scaling up the production of F2 (rice cream) for commercial purposes, including cost analysis and preservation system optimization.

Abstract (English)

In this study, four natural exfoliating creams were formulated using an oil-in-water (O/W) emulsion base. The exfoliating agents used were coffee grounds (F1, 8%), rice powder (F2, 8%), jojoba seeds powder (F3, 8%), and a mixture of coffee grounds and rice powder (F4, 4% + 4%). The formulations were evaluated for their physicochemical properties, pH, viscosity, stability under different storage conditions (4°C, 25°C, 40°C), skin irritation, antimicrobial activity, and morphological characteristics using SEM-EDS analysis. The results showed that F2 (rice cream 8%) was the most stable formulation under all storage conditions, with a skin-compatible pH (5.0), excellent shear-thinning behavior (viscosity decrease of 98.4%), and no skin irritation. F4 (mixture) exhibited the highest viscosity at rest (260,300 mPa.s) and the lowest pH (4.9), but showed poor thermal stability due to the presence of coffee particles. The natural rice-based cream (F2) showed no antimicrobial activity in the agar diffusion test (0 cm), while the commercial cream showed significant activity (1.3–1.4 cm), reflecting different preservation strategies. In conclusion, F2 (rice powder 8%) is the best formulation in terms of stability, texture, and skin compatibility, making it a promising candidate for natural exfoliating cream development.

Keywords: Exfoliating cream, natural exfoliants, coffee, rice, jojoba, stability, pH, viscosity, SEM-EDX, green cosmetics.

Résumé (Français)

Dans cette étude, quatre crèmes exfoliantes naturelles ont été formulées à l'aide d'une émulsion huile-dans-eau (H/E). Les agents exfoliants utilisés étaient le marc de café (F1, 8%), la poudre de riz (F2, 8%), la poudre de graines de jojoba (F3, 8%) et un mélange de marc de café et de poudre de riz (F4, 4% + 4%). Les formulations ont été évaluées pour leurs propriétés physicochimiques, leur pH, leur viscosité, leur stabilité dans différentes conditions de stockage (4°C, 25°C, 40°C), l'irritation cutanée, l'activité antimicrobienne et les caractéristiques morphologiques par analyse SEM-EDS. Les résultats ont montré que F2 (crème de riz 8%) était la formulation la plus stable dans toutes les conditions de stockage, avec un pH compatible avec la peau (5,0), un excellent comportement rhéofluidifiant (diminution de viscosité de 98,4%) et aucune irritation cutanée. F4 (mélange) a présenté la viscosité la plus élevée au repos (260 300 mPa.s) et le pH le plus bas (4,9), mais une faible stabilité thermique en raison de la présence de particules de café. La crème naturelle à base de riz (F2) n'a montré aucune activité antimicrobienne dans le test de diffusion sur gélose (0 cm), tandis que la crème commerciale a montré une activité significative (1,3–1,4 cm), reflétant différentes stratégies de conservation. En conclusion, F2 (poudre de riz 8%) est la meilleure formulation en termes de stabilité, de texture et de compatibilité cutanée, ce qui en fait un candidat prometteur pour le développement de crèmes exfoliantes naturelles.

Mots-clés : Crème exfoliante, exfoliants naturels, café, riz, jojoba, stabilité, pH, viscosité, SEM-EDS, cosmétiques verts.

الملخص (العربية)

في هذه الدراسة، تم تحضير أربعة كريمات مقشرة طبيعية باستخدام مستحلب زيت في ماء كانت العوامل المقشرة المستخدمة هي: 8%مسحوق البنF1 ، 8%(، مسحوق الأرزF2) ، 8%(، مسحوق بذور الجوجوباF3) ، وخليط من مسحوق البن والأرزF4) ، 4% .(4% + تم تقييم التركيبات من حيث خواصها الفيزيوكيميائية، الأس الهيدروجيني(pH) ، اللزوجة، الثبات تحت ظروف تخزين مختلفة4°C) ، 25°C، 40°C)، تهيج الجلد، النشاط المضاد للميكروبات، والخصائص المورفولوجية باستخدام تحليل SEM-EDS. أظهرت النتائج أن التركيبة F2 (كريم الأرز 8%) كانت الأكثر ثباتاً تحت جميع ظروف التخزين، مع أس هيدروجيني متوافق مع الجلد (5.0)، وسلوك ممتاز في القص (انخفاض في اللزوجة بنسبة 98.4%)، وعدم وجود تهيج جلدي. أظهرت التركيبة F4 (الخليط) أعلى لزوجة عند السكون (260,300 mPa.s) وأقل أس هيدروجيني (4.9)، لكنها أظهرت ثباتاً حرارياً ضعيفاً بسبب وجود جزيئات البن لم يُظهر كريم الأرز الطبيعي (F2) أي نشاط مضاد للميكروبات في اختبار الانتشار على الأجار (0 سم)، بينما أظهر الكريم التجاري نشاطاً واضحاً (1.3–1.4 سم)، مما يعكس استراتيجيات حفظ مختلفة. الخلاصة: التركيبة F2 (مسحوق الأرز 8%) هي الأفضل من حيث الثبات، الملمس، والتوافق مع الجلد، مما يجعلها مرشحة واعدة لتطوير كريمات مقشرة طبيعية.

الكلمات المفتاحية: كريم مقشر، مقشرات طبيعية، بن، أرز، جوجوبا، ثبات، أس هيدروجيني، لزوجة، SEM-EDS، مستحضرات تجميل خضراء..