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Theme

Ethnobotanical, phytochemical and biological activities of extracts from *Cymbopogon schoenanthus* (L.) Spreng.

Publicly defended on 16/06/2025 before the jury composed of:

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Dedication

To my beloved parents

To my lovely sister and my supportive brothers

To my dearest friends

and to my cat

Razika

Dedication

With deepest gratitude, I dedicate this work to my beloved parents, for their endless love and support, to my dear sisters and brothers, for their constant encouragement and camaraderie, to my cherished friends, for their invaluable companionship and motivation, and to my beloved cats, for their comforting presence throughout this journey.

Aya

Abstract

Cymbopogon schoenanthus (L.) Spreng, a plant widely used in traditional medicine and locally known as "El Lamad," was selected following an ethnobotanical study conducted in Ghardaïa. this study led to identify 84 medicinal plant species, with *C. schoenanthus* being the most frequently used among them. This study aimed to analyze the phytochemical composition of the plant and evaluate its antioxidant, antibacterial, toxicity, and analgesic properties. Maceration extraction yielded the highest quantity (7.26%) in the crude extract (CrE), which was further fractionated into four extracts: hexane extract (HE), ethyl acetate extract (EAE), chloroform extract (CE), and aqueous extract (AE). Phytochemical analysis revealed that the EAE contained the highest levels of total phenols (322.43±8.267 µg GAE/mg Ex) and total flavonoids (45.53±21.88 µg QE/mg Ex), highlighting its significant bioactive potential. The *in vitro* antioxidant activity of the extracts was evaluated using four methods: the TAC, DPPH, ABTS, and reducing power tests. The results of the antioxidant activity revealed that all the extracts were effective. By using the DPPH, ABTS and FRAP tests, EAE appeared to have the most potent anti-radical (IC_{50}=16.82±0.05 µg/mL), ABTS (IC_{50}=92.01±1.95 µg/mL) and reducing power ($A_{0.5}$=65.66±1.88 µg/mL). The evaluation of the antibacterial activity against four bacterial strains revealed weak antibacterial effects against both Gram+ and Gram- strains. The acute toxicity of CrE was carried out using mice. The administered dose did not result in mortality or changes in general behaviors. The LD_{50} was found to be superior to 2000 mg/kg. *In vivo* assessment of the analgesic effect showed that the CrE exhibited significant inhibition (73.13±2.07%). *Cymbopogon schoenanthus* (L.) Spreng demonstrated strong *in vitro* antioxidant activity, was non-toxic, and exhibited notable analgesic effects, supporting its traditional medicinal uses.

Key words: Ethnobotanical study, *Cymbopogon schoenanthus* (L.) Spreng., phytochemical analysis, antioxidant activity, antibacterial activity, acute toxicity, analgesic effect.

Résumé

Cymbopogon schoenanthus (L.) Spreng., une plante largement utilisée en médecine traditionnelle et connue localement sous le nom de "El Lamad", a été sélectionnée suite à une enquête ethnobotanique réalisée à Ghardaïa. Cette étude a permis d'identifier 84 espèces de plantes médicinales, avec *C. schoenanthus* comme la plus fréquemment employée. Cette étude visait à analyser la composition phytochimique de la plante et à évaluer ses propriétés antioxydantes, antibactériennes, toxiques et analgésiques. L'extraction par macération a donné le rendement le plus élevé (7,26%) dans l'extrait brut (CrE), qui a ensuite été fractionné en quatre extraits : l'extrait d'hexane (HE), l'extrait d'acétate d'éthyle (EAE), l'extrait de chloroforme (CE) et l'extrait aqueux (AE). L'analyse phytochimique a révélé que l'EAE contenait les teneurs les plus élevées en phénols totaux (322,43 ± 8,267 µg EAG/mg Ex) et en flavonoïdes totaux (45,53 ± 21,88 µg EQ/mg Ex), soulignant ainsi son potentiel bioactif significatif. L'activité antioxydante *in vitro* des extraits a été évaluée à l'aide de quatre méthodes : les tests CAT, DPPH, ABTS et du pouvoir réducteur. Les résultats ont révélé que tous les extraits étaient efficaces. Dans les tests DPPH, ABTS et FRAP, EAE a présenté la plus forte activité antiradicalaire (IC_{50}=16,82±0,05 µg/mL), ABTS (IC_{50}=92,01±1,95 µg/mL) et pouvoir réducteur ($A_{0,5}$ = 65,66 ± 1,88 µg/mL). L'évaluation de l'activité antibactérienne contre quatre souches bactériennes a montré des effets antibactériens faibles, tant sur les souches Gram+ que Gram-. La toxicité aiguë de CrE a été réalisée sur les souris. La dose administrée n'a pas provoqué de mortalité ou de changements dans les comportements généraux des souris testés. La DL_{50} s'est révélée supérieure à 2000 mg/kg. L'évaluation *in vivo* de l'effet analgésique a révélé que l'extrait brut présentait une inhibition significative (73,13 ± 2,07 %). En conclusion, *Cymbopogon schoenanthus* (L.) Spreng a démontré une forte activité antioxydante *in vitro*, une absence de toxicité et des effets analgésiques notables, confirmant ainsi son utilisation en médecine traditionnelle.

Mots-clés: Étude ethnobotanique, *Cymbopogon schoenanthus* (L.) Spreng., analyse phytochimique, activité antioxydante, activité antibactérienne, toxicité aiguë, effet analgésique.

الملخص

تم اختيار نباتSpreng (L.) *Cymbopogon schoenanthus* ، المعروف محليًا باسم "اللماد"، والذي يُستخدم على نطاق واسع في الطب التقليدي، وذلك بناءً على دراسة إثنوبوتانية أُجريت في منطقة غرداية، حيث تم تحديد 84 نوعًا من النباتات الطبية، وكان *C. schoenanthus* الأكثر استخدامًا بينها. هدفت هذه الدراسة إلى تحليل التركيب الكيميائي النباتي لهذا النبات وتقييم خصائصه المضادة للأكسدة، والمضادة للبكتيريا، والسُمية، والمسكنة للألم. أظهرت عملية الاستخلاص بالنقع أعلى مردود (7.26%) في المستخلص الخام(CrE) ، والذي تم تقسيمه لاحقًا إلى أربعة مستخلصات: مستخلص الهكسان(HE) ، مستخلص أسيتات الإيثيل(EAE) ، مستخلص الكلوروفورم(CE) ، والمستخلص المائي .(AE) كشفت التحاليل الكيميائية النباتية أن مستخلص أسيتات الإيثيل (EAE) احتوى على أعلى مستويات من الفينولات الكلية (322.43±8.267 ميكروغرام مكافئ حمض الغاليك/ملغ مستخلص) والفلافونويدات الكلية (45.53±21.88 ميكروغرام مكافئ كيرسيتين/ملغ مستخلص)، مما يبرز إمكاناته البيولوجية النشطة. تم تقييم النشاط المضاد للأكسدة في المختبر باستخدام أربع طرق: القدرة المضادة للأكسدة الكلية(TAC) ، واختبارDPPH ، واختبارABTS ، واختبار القدرة الاختزالية. أظهرت نتائج النشاط المضاد للأكسدة أن جميع المستخلصات كانت فعّالة. وباستخدام اختبارات DPPH و ABTSوFRAP، ظهر أن مستخلص أسيتات الإيثيل (EAE) يمتلك أقوى نشاط مضاد للجذور الحرة ABTS (IC50=92.01±1.95 ميكروغرام/مل(، و IC_{50}=16.82±0.05)ميكروغرام/مل(، وقدرة اختزالية $A_{0.5}$=65.66±1.88)ميكروغرام/مل (على التوالي. أما تقييم النشاط المضاد للبكتيريا ضد أربع سلالات بكتيرية فقد أظهر تأثيرًا ضعيفًا ضد السلالات موجبة وسالبة الجرام. تم اختبار السمية الحادة للمستخلص الخام (CrE) على الفئران، ولم تسبب الجرعة المعطاة أي وفيات أو تغييرات في السلوك العام، حيث كانت قيمة LD_{50} أكبر من 2000 ملغ/كلغ. كما أظهر التقييم الحيوي لتأثيره المسكن للألم أن المستخلص الخام أظهر تثبيطًا ملحوظًا (73.13±2.07%). في الختام، أظهر نبات Spreng (L.) *Cymbopogon schoenanthus* نشاطًا قويًا كمضاد للأكسدة في المختبر، وكان غير سام، وبرزت له تأثيرات مسكنة ملحوظة، مما يدعم استخدامه في الطب التقليدي.

الكلمات المفتاحية : دراسة إثنوبوتانية، Spreng (L.) *Cymbopogon schoenanthus* ، تحليل كيميائي نباتي، نشاط مضاد للأكسدة، نشاط مضاد للبكتيريا، سمية حادة، تأثير مسكن للألم.

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AAE: Ascorbic Acid Equivalent
ABTS: 2,2'-Azino-bis (3-ethylbenzothiazoline-6-sulfonic acid)
AE: Aqueous Extract
ALP: Alkaline Phosphatase
ALT: Glutamate Pyruvate Transaminase
AST: Glutamate Oxaloacetate Transaminase
BHT: Butylated Hydroxytoluene
CAT: Catalase
CE: Chloroform Extract
CrE: Crude Extract
DMSO: Dimethyl Sulfoxide
DPPH: 2,2-Diphenyl-1-picrylhydrazyl
EAE: Ethyl Acetate Extract
EC_{50}: Effective Concentration
Ex: Extract
FRAP: Ferric Reducing Antioxidant Power
GAE: Gallic Acid Equivalent
GPx: Glutathione Peroxidase
GRx: Glutathione Reductase
HE: Hexane Extract
IC_{50}: Half-maximal inhibitory concentration
LD_{50}: Lethal Dose, 50%
OD: Optical Density
QE: Quercetin Equivalent
RNS: Reactive Nitrogen Species
ROS: Reactive Oxygen Species
SD: Standard Deviation
SEM: Standard Error of the Mean
SOD: Superoxide Dismutase
TAC: Total antioxidant capacity
TCA: Trichloroacetic Acid
TFC: Total Flavonoid Content
TG: Triglycerides
TPC: Total Polyphenolic Content

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Introduction

In the 21st century, rising pollution, unhealthy lifestyles, and exposure to environmental toxins have significantly increased the risk of various diseases. Moreover, the side effects and the inappropriate use of conventional drugs have become an emerging concern. In response, the World Health Organization (WHO) developed and launched the WHO traditional medicine strategy 2014–2023 in 2013, emphasizing the integration of traditional and complementary medicine into healthcare systems to promote universal health coverage and ensure the quality, safety, and effectiveness of these medical practices **(Hoenders *et al*., 2024)**. Therefore, to prevent such issues and provide everyone with access to basic healthcare, the world is seeking more affordable, readily available, and physiologically appropriate traditional medical systems **(Sen & Chakraborty, 2017)**.

Dating back to ancient times, plants have been used for medicinal purposes and continue to play a vital role in healthcare today. Early use was based on trial and error, as people sought relief from illness or discomfort, gradually identifying plants with beneficial effects. Over generations, this knowledge evolved and was passed down, forming a key part of traditional medicine and contributing to the field now known as ethnobotany **(Ojah, 2020; Salmerón-Manzano *et al*., 2020; Belhouala & Benarba, 2021)**. The field, which explores the relationships between people and plants, has gained prominence in recent decades. Ethnobotanical studies have played a crucial role in identifying plants with potential pharmacological properties, thereby guiding scientific research toward novel drug discovery **(Domingo-Fernández *et al*., 2023; Aremu *et al*., 2024)**.

Biological screening of plant extracts further substantiates their pharmacological potential. Extensive research has demonstrated that plant-derived compounds exhibit a range of biological activities, including antioxidant, antimicrobial, and anti-inflammatory effects. These bioactivities are primarily attributed to secondary metabolites, such as polyphenols, flavonoids, and alkaloids, which play crucial roles in plant defense mechanisms and have therapeutic potential in humans **(Riaz *et al*., 2023)**. Integrating traditional knowledge with scientific methodologies enhances the discovery and development of novel pharmacological agents, reinforcing the value of ethnobotanical studies in modern medicine **(Mitropoulou *et al*., 2023)**.

In Algeria, many authors have documented traditional phytotherapy and ethnobotany through published works. However, the country remains relatively underexplored scientifically despite its

richness in many natural resources, diverse ecosystems, and abundant plant diversity **(Miara *et al*., 2019)**. Among the under-investigated species is *Cymbopogon schoenanthus* (L.) Spreng. a Saharan medicinal plant from the Poaceae family, locally known as "El Lamad". It is traditionally used to treat digestive and genitourinary disorders. However, there is limited scientific data on its phytochemical composition and biological properties. Therefore, our work aims to achieve the following objectives:

- Ethnobotanical study of medicinal plants of the Ghardaïa region.
- Fractionation of the crude extract obtained from *Cymbopogon schoenanthus* (L.) Spreng. and determination of the polyphenols and flavonoids content in the extracts.
- Evaluation of the antioxidant and antibacterial activities *in vitro*.
- Evaluation of the toxicity of the crude extract.
- Evaluation of the crude's extract analgesic effect *in vivo*.

The manuscript is organized into three chapters: the first chapter provides a comprehensive literature review. Furthermore, the second chapter describes the materials and methods employed in conducting the experiments, and the third chapter presents the results obtained, along with their analysis and discussion, concluding with a summary and future perspectives.

Literature review

1. Ethnobotanical study

1.1. Definition

An ethnobotanical study is a scientific investigation that generally focuses on documenting and analyzing the traditional knowledge and connection between local inhabitants and local plants, including practices and the uses of flora by native and rustic communities. It aims to highlight and understand the value of native plant species, preserve the cultural heritage of plant use, discover medicinal species, and examine their potential roles in modern healthcare while aiding in preserving biodiversity and ancestral knowledge **(Senouci *et al*., 2019)**.

1.2. History of ethnobotany

Ethnobotany is an interdisciplinary field investigating the dynamic relationships between human societies and plants, including their uses in medicine, food, rituals, and material culture **(Chen & Akamine, 2021)**. The history of ethnobotany traces the progression from early indigenous plant knowledge to its recognition as a scientific discipline, highlighting both cultural and ecological dimensions. The term ethnobotany was born under the pen of the American professor **J.W. Harshberger** on **December 5, 1895**. The professor defined this discipline as the science of the use of plants by indigenous communities and, from then till **1978, Ford** wrote that "ethnobotany is the study of the direct interrelationships between humans and plants." **(Rahman *et al*., 2019)**. The ethnobotanical research has experienced a significant evolution over the years. In the 21st Century, emerging trends include digital ethnobotany, climate-resilient plant use, and decolonizing research methodologies **(Banisetti & Kosuri, 2023)**.

1.3. Objective and importance

- **Documentation of traditional knowledge**: Ethnobotanical studies seek to document the ancestral knowledge of aboriginal and local communities regarding the multiple uses of plants for medicinal, cultural, and other purposes. This helps preserve knowledge that is often passed down orally and is at risk of being lost due to modernization and cultural changes (**Benarba *et al*., 2015)**.

- **Identification of medicinal plants:** Ethnobotanical research aims to identify different and evaluate plant species used in traditional medicine and their many healing applications. This exploration can contribute mainly to the discovery of new bioactive compounds for pharmaceutical development **(Zatout *et al*., 2021)**.

- **Conservation of biodiversity:** Ethnobotanical studies support plant biodiversity preservation by identifying species that face overharvesting or are at risk of extinction due to their medicinal or cultural significance **(Heywood, 2011)**.

Ethnobotanical studies have significant importance in:

- **Preservation of cultural heritage**: Ethnobotanical studies are vital for preserving and keeping the cultural heritage of indigenous and local communities, as they document all the traditional uses of plants that are deeply rooted in cultural practices **(Prance *et al*., 1987)**.

- **Contribution to modern medicine**: Ethnobotanical studies provide valuable concepts into the medicinal properties of plants, which mainly contribute to the discovery of new drugs and treatments. Many modern pharmaceuticals are derived from plant-based traditional remedies **(Ncube *et al*., 2008)**.

- **Sustainable use of natural resources:** Ethnobotanical studies primarily promote the sustainable use of plant resources by identifying numerous species that are over-harvested and recommending different conservation strategies **(Heywood, 2011)**.

- **Empowerment of local communities:** Ethnobotanical studies encourage local people by recognizing their traditional knowledge and practices, which can yield economic rewards through the sustainable commercialization of medicinal plants **(Eddouks *et al*., 2017)**.

- **Understanding the human-plant relationships**: Ethnobotanical studies offer insights into the remarkably complex relationships between humans and plants, including how cultural, environmental, and economic factors influence plant use **(Quave *et al*., 2012)**.

2. Medicinal and aromatic plants

2.1. Definition

A medicinal plant is a plant, whose parts are utilized in their natural form or included in preparations in order to operate as a therapeutic agent in treating conditions or diseases. Understanding the curative traits of a medicinal plant to deal with different conditions illustrates a vital resource in preserving the culture and biodiversity of distinct nations **(Maldonado, 2021)**. Meanwhile, aromatic plants, commonly referred to as spices and herbs, are those that consist of bioactive molecules, particularly essential oils that easily evaporate at room temperature. The latter are known for being a mixture of secondary metabolites that could be extracted from different constituents of the plant **(Samarth *et al*., 2017)**.

2.2. Cultural and therapeutic value of medicinal plants

Regardless of the progress made in the modernized pharmaceutical and medical sectors, the use of aromatic and therapeutic plants has become a primordial aspect of a regular routine throughout the centuries. These days, they are increasingly being used in alternative treatments, meals, teas, and cosmetics. This trend toward greener economics and lifestyles includes the growing interest in herbs and their cost-effective applications **(Ghorbanpour *et al*., 2017)**. Hence, they share the trait of being rich in compounds known as active principles, which have unique chemical, biochemical, or organoleptic qualities that make them suitable for culinary, medicinal, and aromatic applications. Their practical uses in culinary, cosmetics, medications, and household and commercial goods are essentially limitless **(Namdeo, 2018).**

2.3. Preparation methods

There are several ways of preparation methods for herbal remedies. According to **Nafiu (2017)** the chosen method varies based on the plant used and the treated condition, some of these methods include:

2.3.1. Concoction

This method involves using various plant parts that are either soaked or boiled for a specific duration to extract their medicinal properties. When boiled, the preparation typically lasts 15–20 minutes, whereas soaking can extend up to three days to ensure thorough extraction. In some cases, the remedy is prepared as a soup by incorporating additional ingredients such as dried chameleons, snails, and dried toads. The final preparation is intended for consumption within a single day **(Nafiu, 2017)**.

2.3.2. Decoction

A decoction is a traditional and practical method used to extract heat-stable, water-soluble compounds from tough plant materials like roots, barks, and stems. The process involves chopping the plant parts into smaller pieces, soaking them in water, and then boiling the mixture in a covered container for about 15 to 20 minutes. Once boiled, the decoction is strained, cooled, and stored in the refrigerator, remaining effective for 2 to 3 days. This method is ideal for breaking down fibrous plant structures and maximizing the extraction of beneficial compounds that withstand high temperatures **(Mathews *et al*., 2024)**.

2.3.3. Infusion

Infusions are made from either fresh or dried herbs by steeping the plant parts in hot water for approximately 10 minutes. Afterward, the mixture is strained and can be consumed either hot or cold. These preparations are intended for use within the same day **(Shaik *et al*., 2023)**.

2.3.4. Pills

This method, commonly referred to as "honey pills," involves mixing powdered herbal materials with an equal amount of honey. The mixture is allowed to cool, then shaped into tubular strands and cut into small pieces, which are subsequently air-dried and stored. In cases where honey is unavailable, cane sugar may be used as a substitute **(Nafiu, 2017)**.

2.3.5. Powder

This is the most common and straightforward method for preparing herbal materials. Using a mortar and pestle, thoroughly dried plant parts are crushed and ground into a fine, uniform powder. The resulting powder is stored in clean, dry bottles and should be as finely ground as possible to enhance solubility and ensure effective use **(Tembane, 2023)**.

2.3.6. Tinctures

Tinctures are prepared by soaking fresh or dried herbal materials in 40–60% alcohol. The standard ratio is one-part herb to five parts distilled sprit (ethanol). The mixture is stored in an airtight container. The mixture should be shaken or stirred at least once daily to ensure proper extraction. Alcoholic decoctions help preserve essential compounds for an extended period. Once the extraction process is complete, the liquid is strained and transferred to an airtight glass jar for storage. The recommended dosage typically ranges from five to twenty drops, either taken directly or diluted in water. Another method involves boiling the alcohol with the selected herbs in water and then transferring the solution to a sealed container. After two weeks of use, the remaining residue can be repurposed to make ointments **(Nafiu, 2017)**.

2.3.7. Tablets

The selected herbs are first ground into a fine powder and thoroughly mixed. To form tablets, an appropriate amount of starch or rice paste is added to the powdered mixture, which is then vigorously mixed and kneaded by hand into a pliable, paste-like consistency. Small, round tablets are shaped from this material using improvised tablet-making tools, often crafted from wood or metal **(Nafiu, 2017)**.

2.3.8. Syrup

This preparation involves dissolving a measured amount of cane sugar in boiling water until fully liquefied. The selected herb is added to the boiling water, followed by further boiling and straining to obtain the herbal extract. This extract is then mixed with the prepared cane sugar syrup. If the syrup is not added immediately, a preservative such as benzoic acid should be included to ensure long-term stability and prevent microbial growth **(Patil *et al*., 2019)**.

2.3.9. Poultice

A poultice, also known as a paste, is prepared by grinding or crushing the desired plant materials, either dried or fresh, together with a small amount of water, oil, or honey. The resulting mixture is then spread onto a clean cloth or a piece of banana trunk and applied or tied directly to the affected area. Alternatively, the crushed plant material can be boiled to form a pulp before application **(Romm *et al*., 2010)**.

2.3.10. Compresses

A clean, soaked cloth, usually moistened with an infusion or decoction, is applied to the affected area. Compresses are typically gentler in action compared to poultices **(Nafiu, 2017)**.

2.3.11. Juices

These preparations are made by pounding fresh plant parts, followed by filtering through a fine cloth or squeezing to extract the juice **(Tembane, 2023)**.

2.4. Used plant parts

The plant parts used by traditional healers for preparing medicinal remedies vary. Fresh specimens from commonly available plants are most frequently utilized, likely due to their perceived greater effectiveness. Fresh plant materials retain active compounds better than dried ones, which may lose potency over time. Among the various parts used, leaves and roots are the most commonly employed in remedy preparation, as they are believed to be more effective in treating illnesses than other plant parts **(Moges & Moges, 2020)**.

2.5. Safety

Although the therapeutic benefits of aromatic medicinal herbs and their essential oils (EOs) have been extensively researched, clinical uses depend heavily on their safety profiles, especially with regard to acute and chronic toxicity. Furthermore, the possible teratogenic and embryotoxic effects of using medicinal plants during pregnancy have sparked concerns. One

major safety concern is allergic reactions to fragrant therapeutic plants. These plants contain volatile substances that have been linked to allergies. This emphasizes how allergenic components in therapeutic plant extracts must be closely monitored and controlled to avoid negative reactions in vulnerable groups. Establishing safe dosage and administration guidelines for aromatic medicinal plants is essential to maximize their therapeutic benefits while minimizing risks **(Li & Wang, 2024)**.

2.6. Application

Plant-based healing practices likely began with the emergence of *Homo sapiens*, nature has provided therapeutic substances for thousands of years. The business and scientific community are interested in medicinal and aromatic plants (MAPs) because they generate a wide range of phytochemicals that are beneficial to humans. Spices, condiments, essential oils, extracts, nutraceuticals, food, cosmetics, natural colors, natural biocides, and many more components are all included in these items. These days, there is a growing global demand for these plants and the goods made from them. Since they supply the majority of the therapeutic compounds in many traditional health care systems, MAPs really represent the largest number of plant species used by humans for medical interests. However, the application of these plants extends beyond clinical science. In addition to their well-known applications as natural insecticides, colors, tannins, and other substances, they are also used in the food, beverage, cosmetic, and fragrance sectors. These further applications of MAPs are crucial given their expanding market potential and economic significance. With over 2000 species, plant extracts have been employed as insecticides **(Arraiza *et al*., 2017)**.

3. Phytochemical study

3.1. Definition

Phytochemicals is a wide-ranging term that refers to chemicals that are derived from plants via primary or secondary metabolic pathways. They are of paramount importance regarding the defense against biotic and abiotic materials **(Qi *et al*., 2023)**. Most phytochemicals are secondary plant metabolites found in a wide range of foods, including fruits, vegetables, cereals, and nuts, as well as in beverages such as tea, juice, and coffee. Phytochemicals are commonly classified into seven major categories, according to the chemical structures as phenolic compounds, terpenes, betalains, organosulfides, indoles, glucosinolates, sulfur compounds, protein inhibitors, and other organic acids **(Zhang *et al*., 2019)**. Owing to their unparalleled chemical diversity, plant-derived products whether in the form of pure

compounds or standardized extracts offer vast potential for the discovery of novel drug leads. Phytochemical analysis plays a crucial role in identifying bioactive compounds within plants, serving as a foundation for the development of new therapies and treatments **(Siddiqui & Moid, 2022)**.

3.2. Classification of bioactive compounds

3.2.1. Primary compounds

Plants naturally synthesize a diverse array of chemical compounds that support their growth and development. Primary metabolites play a crucial role by supplying essential substances needed for fundamental processes such as photosynthesis, respiration, and translocation **(Hasan & Twaij, 2022)**.

3.2.2. Secondary compounds

Secondary compounds are considered as products derived from primary compounds, which are formed via modified biosynthesis pathways. They are undoubtedly more complex in structural composition and side chains compared to primary metabolites. There are four main groups of secondary compounds, phenolic groups, terpenes, steroids, and nitrogen-containing compounds **(Hasan & Twaij, 2022).**

3.2.3. Types of bioactive compounds

3.2.3.1. Polyphenols

Polyphenols are a diverse group of phytochemicals characterized by aromatic rings with hydroxyl groups, playing vital roles in plant defense and human health **(Quideau *et al*., 2011)**. These compounds are classified into flavonoids (e.g., quercetin, catechins), phenolic acids (e.g., gallic acid, chlorogenic acid), stilbenes (e.g., resveratrol), and lignans, each exhibiting unique biological activities **(Pandey & Rizvi, 2009)**. Their antioxidant properties stem from the ability to donate hydrogen atoms or electrons to neutralize free radicals **(Hassan *et al*., 2020)**.

3.2.3.2. Phenolic acids

Phenolic acids are a diverse class of phytochemicals found in all plant-based foods. These secondary metabolites contain an aromatic ring with hydroxyl groups and various side chains. They serve as a plant's first line of defense against biotic and abiotic stresses while influencing food attributes such as color, flavor, and stability. Additionally, they offer

numerous health benefits, including anti-inflammatory, antibacterial, antiproliferative, anticarcinogenic, and antioxidant properties **(Chandrasekara, 2019)**.

3.2.3.3. Flavonoids

Flavonoids are a major subclass of polyphenolic compounds characterized by a 15-carbon skeleton (C6-C3-C6) consisting of two aromatic rings connected by a three-carbon bridge **(Kumar & Pandey, 2013)**. These bioactive phytochemicals are classified into six principal subgroups: flavanols, flavones, flavanones, flavan-3-ols, anthocyanidins and isoflavones **(Panche *et al*., 2016)**. Their biological activities primarily stem from their free radical scavenging and metal ion chelation properties **(Williams *et al*., 2004)**. Recently, these compounds have gained prominence for their broad pharmacological properties, including anticancer (cytotoxic), antimicrobial, and anti-inflammatory activities **(Siddiqui & Moid, 2022)**.

3.2.3.4. Lignin

Lignin is a complex phenolic biopolymer that serves as a major structural component in plant cell walls, providing mechanical strength and hydrophobicity to vascular tissues **(Boerjan *et al*., 2003)**. It forms through the oxidative polymerization of three phenylpropanoid monolignols: p-coumaryl alcohol (H-unit), coniferyl alcohol (G-unit), and sinapyl alcohol (S-unit) **(Katahira *et al*., 2018)**. Recent advances in lignin valorization have highlighted its potential as a renewable source of aromatic chemicals and carbon materials, driving innovations in biorefinery technologies **(Ragauskas *et al*., 2014)**. The polymer's antioxidant and antimicrobial properties have also prompted investigations into pharmaceutical and food packaging applications **(Domenek *et al*., 2013)**.

3.2.3.5. Tannins

Tannins are plant-derived polyphenols that have gained significant attention for their multifaceted biological activities and sustainable applications **(Shirmohammadli *et al*., 2018)**. Modern classifications divide tannins into hydrolysable (gallotannins, ellagitannins) and condensed (proanthocyanidins) types, with recent studies identifying complex hybrid tannins in some species. These compounds exhibit broad bioactivity, functioning as antioxidants (radical scavengers), antimicrobials, anti-inflammatories, anticancer and hemostatic agents in medicine while industrially serving as clarifiers in beverages like wine and beer **(Koopmann *et al*., 2020)**.

3.2.3.6. Coumarins

Coumarins, a class of plant-derived secondary metabolites. They are found in many plant species like essential oils of Rubiaceae, and Poaceae plants, and are best recognized in the form of Citrus, Bergamini's, and bergamot oil. They play a major role in plant defense against phytopathogens, environmental stresses response, and oxidative stress control **(Khan *et al*., 2023)**.

3.2.3.7. Anthocyanins

Anthocyanins are water-soluble flavonoid pigments responsible for red, purple, and blue hues in fruits and flowers, with over 700 structurally identified variants. These compounds consist of an anthocyanidin core glycosylated with mono- or di-saccharides, which influence their stability and bioavailability **(Zilic *et al*., 2019)**. It possesses antioxidant capacity and anti-inflammatory effects, which are mediated through NF-κB and NLRP3 inflammasome inhibition **(Molagoda *et al*., 2021)**. Clinical trials highlight their role in insulin sensitivity **(Mao *et al*., 2023)**. In food science, anthocyanins are exploited as natural colorants (E163 code) with pH-dependent properties **(Roy & Rhim, 2021)**.

3.3. Extraction techniques

3.3.1 Maceration

This technique is a liquid-solid extraction that revolves around placing powdered drug material into a container and covered it with a solvent. After that, the container is sealed and stored for a minimum of three days. Periodically, the content is stirred, and to guarantee full extraction, it should occasionally be shaken. At the end of the extraction, filtration or decantation is used. The micelle is then isolated from the menstruum by evaporation. This method is ideal for heat-sensitive plant materials and is considered highly practical **(Abubakar and Haque, 2020)**.

3.3.2. Infusion

Infusion is a method of extraction that involves steeping plant material in boiling water to obtain a dilute solution of its readily soluble constituents. The plant material is immersed in the hot solvent and left to stand in a covered container for about 15 minutes. After this period, the liquid extract is separated from the solid residue by filtration **(Bitwell *et al*., 2023; Malini *et al*., 2023)**.

3.3.3. Digestion

This is a maceration method that involves applying gentle heat during the extraction process to increase its efficiency **(Manousi *et al*., 2019; Agrahari *et al*., 2021)**. The powdered drug is added to the extraction solvent in a clean container and the mixture is heated over a water bath at around 50°C. This heat reduces the solvent's viscosity and improves the extraction of bioactive compounds. The mixture is allowed to stand for 8 to 12 hours, after which it is filtered **(Rasul, 2018)**.

3.3.4. Percolation

In the percolation method, a percolator which is used to ensure the extraction. The dried, ground, plant is mixed with a solvent, and the mixture is left to stand up to 4 hours. It is then transferred into the percolator to settle for an additional 24 hours. Solvent is subsequently poured into the percolator until the material is covered, after which the fraction would be taken out. In addition, solvent is continuously added until 75% of the total intended volume is reached, and the extract is finally separated by filtration and decantation **(Abubakar & Haque, 2020)**.

4. Biological activities

4.1. Antioxidant activity

4.1.1. Oxidative stress

Oxidative stress is described as the perturbation of the equilibrium between the oxidizing agents and the neutralizing compounds, contributing to the disturbance of redox signalization and control and to direct molecular damage. A high level of oxidative stress may lead to damaged cell constituents, while little or moderate quantities of oxidative stress play a crucial role in normal cell physiology that is expressed by regulating redox-sensitive signaling pathways. A major example of oxidative stress-regulated signaling pathways is the OxyR and SoxR transcription factors for bacteria and Nrf2/Keap1 in higher organisms. Specialized immune defense cells can also release an excessive amount of oxidants against odd pathogens. Immense studies have shown the distinct contribution of oxidative stress and free radicals in aging and in multiple medical disorders like cancer, atherosclerosis and degenerative neurological conditions **(Miranda-Bautista *et al*., 2017)**.

4.1.2. Free radicals and reactive species

Free radicals, are known as chemical entities, such as atoms, molecules, or ions, that exhibit a high degree of reactivity and have one or more unpaired electrons in their exterior orbitals. All biological macromolecules are easily reacted with by oxygen free radicals, which causes oxidative alteration and function loss. As a result, free radicals have two functions in biological systems: they are harmful byproducts of aerobic metabolism that lead to tissue malfunction and oxidative damage, and they are molecular signals that trigger beneficial stress responses **(Di Meo & Venditti, 2020)**. Free radicals play a crucial role in normal cellular functioning. For instance, free radicals contribute to the regulation of cell signaling pathways, on the other hand, a disproportion between free radical formation and the body's capacity to neutralize them contributes to oxidative stress. Excessive free radical synthesis, deficient antioxidant defenses, or both are the main reasons behind the imbalance. Oxidative stress has damaging effects as free radicals interact with essential cell-based components **(Chandimali *et al*., 2025)**.

ROS or Reactive Oxygen Species are the main oxidant species produced during normal cellular metabolism. They are constantly produced in the form of byproducts of enzymatic reactions and cellular respiration. ROS are immensely reactive, consisting of initial molecular species that are produced by the reduction of oxygen in addition to their secondary reactive products and they include free radical and non-radical reactive species **(Miranda-Bautista *et al*., 2017)**.

4.1.3. Types of free radicals

Reactive oxygen species (ROS; e.g., $O_2^{\bullet -}$, •OH, H_2O_2) and reactive nitrogen species (RNS; e.g., NO•, $ONOO^-$) are biologically crucial free radicals with dual physiological/pathological roles. ROS originate primarily from mitochondrial $O_2^{\bullet -}$, which dismutates to H_2O_2 (via SOD) and converts to highly reactive •OH through Fenton reactions (Fe^{2+}/Cu^+-dependent), causing widespread oxidative damage to lipids, proteins, and DNA due to its uncharged diffusibility. RNS, generated by nitric oxide synthases (NOS), mediate vasodilation and immunity but form cytotoxic $ONOO^-$ when overproduced with $O_2^{\bullet -}$, leading to protein tyrosine nitration and disrupted signaling **(Chandimali *et al*., 2025)**.

Table 1. Main reactive oxygen and nitrogen species **(Chandimali *et al*., 2025)**.

Reactive oxygen species (ROS)		**Reactive nitrogen species (RNS)**	
Name	**Symbol**	**Name**	**Symbol**
		Radicals	
Superoxide	O2•−	Nitric oxide	NO•
Hydroxyl	•OH	Nitrogen dioxide	NO2•
Hydroperoxyl	HO2•	Nitrate radical	NO3•
Peroxyl	ROO•		
Alkoxyl	RO•		
Organic hydroperoxide	ROOH		
		Non-radicals	
Hydrogen peroxide	H2O2	Nitrous acid	HNO2
Ozone	O3	Nitrosonium cation	NO+
Singlet oxygen	1O2/Δg	Nitroxyl anion	NO−
Hypochlorous acid	HOCl	Peroxynitrite	ONOO−
Peroxynitrite	ONOO−	Dinitrogen trioxide	N2O3
		Dinitrogen tetroxide	N2O4
		Peroxynitrous acid	ONOOH
		Nitryl chloride	NO2Cl

4.1.4. Sources of free radicals

Endogenous and exogenous sources are the origins of oxidative species. Endogenous sources are represented by diverse cellular organelles including mitochondria, peroxisomes, and endoplasmic reticulum, where the implication rates of oxygen are increased. The cytosol and plasma membrane can also be partly responsible for the endogenous production of oxidant species. Toxins, ultraviolet radiation, alcohol, tobacco smoke, and certain pharmaceutical drugs demonstrate exogenous sources that are responsible for oxidative species production **(Krishnamurthy *et al*., 2024)**.

4.1.5. Target of free radicals

Targets of free radicals are of several types as well as for reactions. Oxidative processes are chemical/biochemical in nature revolving around the process in which electrons are transferred from a donor, acting as a reducing agent, to an acceptor, which functions as the

oxidizing agent. Most molecules exist in a non-radical state, and biological systems when a non-radical interferes with a free radical, it triggers a chain of reactions, and when two free radicals interact, their unpaired electrons pair up in order to form a covalent bond. For instance, $NO^{\bullet}$ and $O_2^{\bullet-}$ react rapidly to form ONOO−, a non-radical product that rapidly protonates to peroxynitrous acid (ONOOH), a powerful nitrating and oxidizing substance that can immediately alter proteins, DNA, and lipids. Biological damages can result from systems that produce $NO^{\bullet}$ and $O_2^{\bullet-}$ that are mainly linked to different disorders. Free radical reactions can chemically alter surrounding compounds, engendering the loss of physiological function in living organisms **(Martemucci *et al*., 2022)**.

4.1.6. Antioxidant defense systems

The emergence of a wide range of persistent and degenerative diseases has been provoked by the overproduction of reactive oxygen and nitrogen species. The body possesses innate antioxidant defense mechanisms to protect against the harmful effects of free radicals, demonstrated by the inhibition of the oxidation process, even at low concentrations, and by suppressing or inhibiting the oxidation of proteins, carbohydrates, lipids and DNA, for the purpose of protecting cells against free-radical damage. Antioxidants act by donating electrons, and those capable of interrupting chain reactions are particularly effective electron donors. They neutralize free radicals early, preventing damage to essential biomolecules. Therefore, oxidized antioxidants must be regenerated or replaced. Antioxidants are either endogenous, and can be broadly categorized into enzymatic antioxidants, such as superoxide dismutase (SOD), catalase (CAT), glutathione peroxidase (GPx) and glutathione reductase (GRx), and non-enzymes as metabolic antioxidants, such as lipoic acid, glutathione, L-arginine, uric acid, bilirubin, as well as dietary or exogenous antioxidant including vitamin E, vitamin C, trace elements like selenium, copper and zinc, and a variety of phytochemicals such as isoflavones, polyphenols and flavonoids. Exogenous and endogenous antioxidants are powerful scavengers of free radicals, by giving electrons to ROS, the negative effects of the latter are neutralized, and oxidative stress is reduced as well as the oxidation of cell molecules **(Martemucci *et al*., 2022)**.

Low-molecular-weight antioxidants such as vitamins C and E, flavonoids, and carotenoids offer only limited protection against free radical-induced damage in biological systems. This is because reactive oxygen species (ROS) interact with critical biomolecules like DNA, proteins, and membrane lipids more rapidly than with these small-molecule antioxidants. Consequently, their radical-scavenging capacity is relatively weak. In contrast, antioxidant

enzymes provide more effective defense. Superoxide dismutases (SODs) convert superoxide radicals into hydrogen peroxide, which is subsequently broken down by catalase and glutathione peroxidase. These enzymatic reactions occur significantly faster than those involving low-molecular-weight antioxidants **(Jomova *et al*., 2024)**.

4.2. Anti-inflammatory activity

4.2.1. Inflammation

Inflammation represents the body's complex protective response to harmful stimuli, including pathogens (bacteria, viruses), cellular damage, or irritants. This physiological process is characterized by: localized immune cell activation, release of inflammatory mediators (e.g., cytokines like TNF-α, chemokines such as IL-8), and targeted leukocyte recruitment. The quintessential clinical manifestations redness, heat, swelling, pain and loss of function **(Chen *et al*., 2017)**.

4.2.2. Anti-inflammatory molecules

Anti-inflammatory molecules are bioactive compounds that minimize inflammation by modulating the immune response and inhibiting the production or activity of pro-inflammatory mediators. These molecules typically can be extracted from natural sources (e.g., plants, foods) or synthesized artificially (e.g., pharmaceutical drugs). They act through various mechanisms, such as inhibiting inflammatory signaling pathways (e.g., NF-κB, MAPK), reducing the production of cytokines (e.g., TNF-α, IL-1β, IL-6), or blocking enzymes (e.g., COX-2, LOX) involved in the inflammatory process. Here are some molecules like: curcumin, resveratrol, epigallocatechin gallate (EGCG), boswellic acids, quercetin, omega-3 fatty acids, NSAIDs, flavonoids **(Vane & Botting, 1996; Salehi *et al*., 2018)**.

4.2.2.1. Steroidal anti-inflammatories

Steroidal anti-inflammatory drugs (SAIDs) or corticosteroids are synthetic glucocorticoids. These are pharmaceutical products that derive from natural cortisone (steroid hormones of the adrenal cortex), mainly glucocorticoids (cortisol) that are biosynthesized from cholesterol and used in the medical field for their antiallergic, hematological and anti-inflammatory properties. Thus, steroidal anti-inflammatory drugs (SAIDs) inhibit the inflammatory reaction by inactivating membrane phospholipase A2 and prevent the release of arachidonic acid, a precursor of prostaglandins (chemical substances involved in the inflammatory response) **(Dejean & Richard, 2013)**.

4.2.2.2. Non-steroidal anti-inflammatories

Non-steroidal anti-inflammatory drugs (NSAIDs) constitute a chemically heterogeneous drug class where aspirin is the leader. They are widely used for their analgesic and antipyretic and antiplatelet action by reducing inflammation, relieving pain, and lowering fever **(Pillon, 2014)**.

Their effectiveness and their main side effects are linked to their main mechanism of action, which is the inhibition of cyclo-oxygenases (COX-1 and COX-2), enzymes responsible for the synthesis of prostaglandins (notably PGE2 and PGI2) and thromboxane from arachidonic acid **(Orliaguet *et al*., 2013)**.

There are two types of these drugs non-selective NSAIDs and selective NSAIDs. The first type is represented by drugs that inhibit both COX-1 and COX-2. The second type of NSAIDs specifically target COX-2. Both types of NSAIDs are effective in relieving and reducing symptoms of inflammation (**Sylvester, 2019)**.

The most well-known non-selective NSAIDs are ibuprofen, aspirin and naproxen. For selective drugs, celecoxib and etoricoxib are mainly used to relieve symptoms of osteoarthritis, rheumatoid arthritis and other inflammatory conditions **(Pipet *et al*., 2012)**.

4.2.2.3. Plant-based anti-inflammatories

Medicinal plants are plant drugs that have long been used in folk medicine to provide relief from inflammatory diseases, fever, pain, etc. where at least part of the plant has medicinal properties **(Ghauri *et al*., 2021)**.

The anti-inflammatory activity of these plants is due to their richness in bioactive secondary metabolites like polyphenols, in particular flavonoids, sterols, alkaloids, coumarins, terpenes, etc. which can act at several levels of the inflammatory reaction **(Meziti, 2018)**.

In recent years, several studies, in vitro and in vivo, are both oriented towards the valorization of traditional medicine in order to verify the anti-inflammatory effect of the plants used, their mechanism of action and to establish scientific rules for the use of these plants **(Meziti, 2018; Rahmani *et al*., 2016)**. Approximately 47 plants and 52 molecules extracted from plants have been found beneficial for the treatment of inflammation and have been proven by clinical and

preclinical studies **(Maione *et al*., 2016)**. The biochemical results of these studies clearly show the potential role of plants and/or their compounds in inhibiting the formation of the main proinflammatory mediators of arachidonic acid metabolism via the inhibition of the enzymes cyclooxygenases and lipoxygenases.

4.3. Antimicrobial activity

4.3.1. Antibiotics and their modes of action

4.3.1.1 Definition

Antibiotics are antimicrobial substances used in treating and preventing bacterial infections by either eliminating the bacteria or halting their proliferation. While mainly effective against bacteria, some of them also alter fungi, human and animal cells, though they generally have little impact on viruses. Their mechanisms of action typically involve disrupting bacterial cell wall structures or preventing bacterial replication **(Muteeb *et al*., 2023)**.

Antibiotics are primarily used for treating and preventing infections, including bacterial, protozoan infections, and for immunomodulation. They are also administered prophylactically to prevent post-operative infections and oral care treatments, and are classified based on their mode of action, targeting either specific bacterial strains or parasites **(Pham, 2018)**.

4.3.1.2. Modes of action

Antibiotics mode of action shifts from one to another however, researchers categorize them based on their functional pathways and constitutional structure **(Kaur Sodhi & Singh, 2022)**.

4.3.1.1.a. Antibiotics inhibit DNA replication

Cell division is the process by which bacteria proliferate, resulting in two genetically identical daughter cells. Before division occurs, bacteria must first replicate their circular DNA through a process called DNA replication. By stopping the function of DNA gyrase and topoisomerase IV, bacterial DNA formation is prevented by fluoroquinolone antibiotics. Thus, these pharmacological agents tend to have a specific tendency to bind to the complex DNA gyrase-DNA which results in destabilizing the enzyme-DNA complex, leading to DNA breakage and subsequent bacterial cell death **(Pham *et al*., 2019; Shree *et al*., 2023)**. Fluoroquinolones main target is DNA gyrase, this explains their efficacy in targeting most gram-negative bacteria. Whereas they affect the binding between topoisomerase IV and DNA in gram-positive bacteria **(Spencer & Panda, 2023)**.

4.3.1.1.b. Antibiotics inhibit protein biosynthesis

Aminoglycosides are antibiotics that work in a certain way. As a result of their positive charge, they draw in the bacterial external membrane with a net negative charge, which leads to the development of huge pores in the membrane. These pores subsequently allow the aminoglycosides to enter the bacterial cell. Furthermore, aminoglycosides can use the energy required for active transport to cross the cell membrane. The 16s rRNA of the 30s is the target of aminoglycosides, which form hydrogen bonds with it. Protein biosynthesis is prevented from being completed by this binding **(Halawa *et al*., 2023)**.

4.3.1.1.c. Antibiotics inhibit cell wall synthesis

This group includes all cephalosporins and penicillins defined by their beta-lactam ring core. Because of their unique structure, they can bind to enzymes involved in peptidoglycan linkage like carboxypeptidase and transpeptidase, which stops cross-linking and bacterial cell wall formation. The bacterial cell is destroyed as a result of this suppression of cell wall production **(Liu & Breukink, 2016)**.

4.3.1.1.d. Antibiotics that inhibit folic acid metabolism

The purpose of these antimicrobial compounds is to specifically block a crucial enzyme in the folic acid metabolism pathway. The metabolic pathway enzyme dihydropteroate synthase is the target of sulfonamide antibiotics. However, dihydrofolate reductase, a different enzyme involved in the same metabolic route, is the target of trimethoprim antibiotics **(Capasso & Supuran, 2014; Fernández-Villa *et al*., 2019)**.

4.3.2. Bacterial resistance to antibiotics

A bacterium is said to be resistant if it can endure or proliferate at concentration levels of antibiotics that typically suppress or eliminate conspecific organisms **(Kaur Sodhi & Singh, 2022)**. The words "susceptible" and "resistant" are frequently utilized in clinical practice to characterize the possibility of an antibiotic therapy being successful. When a patient cannot reach the dose required to hamper or eradicate the microbial agent, resistance is more likely to develop. Antibiotic resistance in microorganisms can develop naturally or as a result of exposure **(Premlatha, 2019)**. In addition to a horizontal transfer of resistance genes, often mediated by plasmids, which are mobile genetic elements and spread through conjugation, transformation or transduction, resistance can also develop as a result of gene mutations. Genetic material, particularly genes that resist antibiotics, can travel quickly, even across

bacteria of different species. The development of biofilms has been shown to accelerate the spread of antibiotic resistance in bacteria **(Halawa *et al*., 2023)**.

4.3.3. Plant antimicrobials and modes of action

Despite lacking complex defense systems like animals, plants have evolved a wide variety of chemical defenses, primarily protein-derived, to detect and counteract potential threats. These chemical compounds help plants recognize invading organisms and prevent significant damage. To defend against pathogens such as bacteria and fungi, plants have formed the ability to recognize harmful microbes and activate triggered defense mechanisms. They achieve this by generating hazardous compounds, microbe-inhibiting substances, and pathogen-degrading enzymes. These protective substances fall into three main categories: terpenoids, phenolics, and alkaloids **(Tiku, 2018)**.

Certain antimicrobial substances are naturally present in plants in an active form, providing constant protection. Others, such as glucosinolates and cyanogenic glycosides, remain inactive until the plant is attacked or its tissues are damaged. When this happens, enzymes are released, triggering these compounds into action. Preformed antimicrobial compounds are known as phytoanticipins, while those synthesized in response to an attack are called phytoalexins. Phytoanticipins are typically found in specific plant tissues, particularly in the outer layers of plant organs, offering broad-spectrum protection. However, some highly specialized pathogens can bypass these defenses by detoxifying or evading them **(Tiku, 2020)**.

Among plant defense compounds, phytoalexins are particularly significant because they are produced only when the plant detects a threat. These pathogen-specific compounds exhibit a pivotal factor in plant defense, requiring transcriptional and translational activity for their synthesis, for instance scopoletin, camalexin, and glucosinolates **(Cao *et al*., 2020)**.

The most well-known and extensively researched modes through which antimicrobial agents act today include, bacterial cell membrane lysis, disruption of cell wall formation, suppression of DNA and RNA formation, interference with protein synthesis, and blockage of metabolic circuits. On the other hand, antibiotic inactivation, enzyme-mediated, antibiotic modification, and bacterial resistance to antibacterial drugs are the most prevalent and researched mechanisms. Combining phytochemicals with conventional antibiotics can be

more effective in preventing resistance propagation since they can work through other mechanisms and targeted sites than typical antibiotics **(Álvarez-Martínez *et al*., 2021)**.

5. Presentation of the studied plant

5.1. General overview

Cymbopogon schoenanthus (L.) Spreng, commonly called "camel grass," is a drought-tolerant perennial grass (60–90 cm tall) native to arid regions of Western Africa, the Arabian desert and Egypt, thriving up to 2,000 m elevation in Iran **(Amina *et al*., 2013)**. Known regionally as "Izkhir" (Arabic), "El bekhirai" (Tunisian), or "El lemad" (North African), it grows in water-scarce environments and serves as camel fodder **(Burkill & Dalziel, 1985)**. Its economic value derives from strong, lemon-scented essential oils, utilized in flavorings, perfumes, and cosmetics **(Chabib *et al*., 2021)**.

Figure 1. Morphological aspect of *Cymbopogon schoenanthus* (L.) Spreng. **(Original photo, 2025)**.

5.2. Systemic position

The classification of camel grass plants is explained as follows **(ITIS, 2020)**:

Kingdom: Plantae

Division: Tracheophyta

Class: Magnoliopsida

Order: Poales

Family: Poaceae

Genus: *Cymbopogon*

Species: *Cymbopogon schoenanthus* (L.) Spreng.

5.3. Geographical distribution

Cymbopogon is a widespread genus comprising approximately 144 species distributed across Africa, Asia, and the Americas. In Africa, its range extends from North Africa (Algeria, Egypt, Libya, Morocco) through the Sahel (Chad, Mali, Mauritania, Niger) to East Africa (Ethiopia, Kenya, Somalia) and West Africa (Benin, Burkina Faso, Ghana, Nigeria, Senegal). However, in Asia, found in the Arabian desert (Iraq, Oman, Saudi Arabia, Yemen), while in the Americas it is naturalized in subtropical regions (southern Florida and California). *Cymbopogon schoenanthus* (L.) Spreng exhibits particularly strong xerophytic adaptations, favoring arid places like deserts **(Al-Snafi, 2016; Zhao *et al*., 2024)**.

5.4. Traditional uses

Cymbopogon schoenanthus (L.) Spreng (camel grass), an arid-adapted species, is ethnomedicinally valued for its broad therapeutic applications, including gastrointestinal (antihelminthic especially against *Dracunculus medinensis*, antispasmodic and detoxification), systemic (antimalarial, antipyretic, diuretic/renal antispasmodic to prevent kidney stones), topical (anti-inflammatory and antifungal for skin/wounds), and respiratory (cold, sore throat and rheumatism relief) treatments, alongside appetite stimulation and clinical air decontamination **(Hashim *et al*., 2017)**.

5.5. Chemical composition

The methanolic extract of *Cymbopogon schoenanthus* displays a rich and diverse chemical composition, predominantly featuring phenolic compounds (gallic acid, chlorogenic acid, caffeic acid) and flavonoids (luteolin, apigenin), which contribute to its potent antioxidant properties **(Abdelazim *et al*., 2018)**. Specific alkaloids particularly vasicinone and schoenanthines A and B have also been identified, accounting for their pharmacological activities, including bronchodilatory and anti-inflammatory effects **(Ahmed *et al*., 2020)**.

Materials and Methods

1. Ethnobotanical study

In this work, an ethnobotanical study was conducted in Ghardaïa between January and February 2025. It aims to collect, analyze, and document traditional plants used by local people for medicinal purposes, as well as their associated knowledge and practices. A survey was conducted using a structured questionnaire (Appendice 1) targeting herbalists, traditional healers, and phytotherapists who possess knowledge and expertise in utilizing medicinal and aromatic plants.

1.1. Presentation of the study area

The study was conducted in the state of Ghardaïa (Figure 2). Ghardaïa is situated in the northern part of the Algerian Sahara, approximately 600 km south of the capital, Algiers, between latitudes 33° and 31°15′ N and longitudes 2°30′ and 5° E. The region has an arid climate characterized by very low annual rainfall (160 mm), extremely high summer temperatures (ranging from 20°C to 45°C), and low winter temperatures. The wilaya of Ghardaïa covers a total area of 86,560 km², representing about 4% of Algeria's national territory.

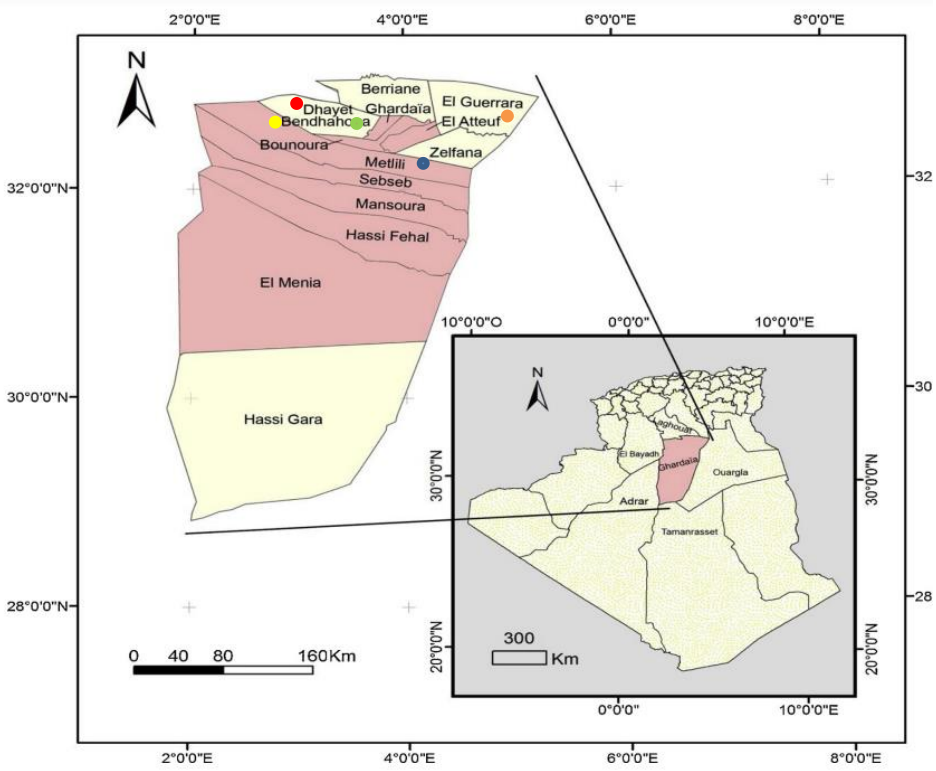

Figure 2. Map of Algeria showing the study area "Ghardaïa state" (Dahayet Bendhahoua in red, Bounoura in yellow, Ghardaïa city in green, El-Atteuf in orange and Metlili in blue) **(Benfodil *et al.*, 2020)**.

1.2. Survey form

The survey form focused on different aspects of the investigation, it included information about:

The informant: such as age, gender, and academic education.
The plant: its common and scientific name, nature (wild or cultivated), season of harvesting, and conservation modes. Preparation methods, dosage used, parts used, and administration modes. Type of condition treated, duration of use, targeted population (children, adults, and pregnant women), and possible interactions.

2. Materials

2.1. Biological material

2.1.1. Plant material

The above-ground part of the plant *Cymbopogon schoenanthus* (L.) Spreng was collected in January 2025 from the Metlili region, Ghardaïa Province. The plant was cleaned, dried in the dark, and then stored at room temperature until further use.

2.1.2. Bacterial strains

The choice of microorganisms was directed towards reference strains from the American Type Culture Collection (ATCC) international collection, namely:

- Gram-positive bacterial strains: *Bacillus subtilis* ATCC 6633 and *Staphylococcus aureus* ATCC 43300.
- Gram-negative reference strains: *Pseudomonas aeruginosa* ATCC 27853 and *Escherichia coli* ATCC 25922.

2.1.3. Animal material

Female *Swiss* albino mice (21-22 g) and female Albino *Wistar* rats (180-210 g) were obtained from the Pasteur Institute of Algiers. Animals were housed in polypropylene cages under standard laboratory conditions (a 12-hour light/dark cycle, with an ambient temperature of 23-25°C) and had free access to food and water. Following a 15-day acclimatization period, animals were fasted overnight, weighed, labeled, and prepared for experimental procedures.

2.2. Non-biological material

2.2.1. Chemicals and equipment

2.2.1.1. Chemicals

The chemical compounds utilized during the study are: methanol (CH_3OH), hexane (C_6H_{14}), ethyl acetate ($C_4H_8O_2$), quercetin ($C_{15}H_{10}O_7$), aluminum trichloride ($AlCl_3$), gallic acid monohydrate ($C_7H_6O_5$), Folin-ciocalteu's phenol reagent, sodium carbonate (Na_2CO_3), 2,2-Diphenyl-1-picrylhydrazyl (DPPH), ascorbic acid ($C_6H_8O_6$), Butylated Hydroxytoluene (BHT), sodium phosphate dibasic dihydrate, ammonium molybdate tetrahydrate, sulfuric acid (H_2SO_4), trichloroacetic acid (TCA), disodium hydrogen phosphate (Na_2HPO_4), ferrous chloride ($FeCl_3$), potassium ferricyanide ($K_3Fe(CN)_6$), 2,2'-Azino-bis(3-ethylbenzothiazoline-6-sulfonic acid) (ABTS), Tween 40, β-Carotene, chloroform, linoleic acid ($C_{18}H_{32}O_2$), potassium persulfate ($K_2S_2O_8$), Mueller-Hinton Agar, xylene, Gentamycin, dimethyl sulfoxide (DMSO) and sodium Diclofenac.

2.2.1.2. Equipment

The equipment used is: shaker (EDMUND Bühler GmbH), balance (OHAUS), rotary evaporator (HEIDOLPH), ultraviolet-visible spectroscopy (SECOMAM), laboratory oven (MEMMERT), water bath (MEMMERT) and microtome (LEICA, Germany).

3. Methods

3.1. Maceration extraction and fractionation

The extraction of phenolic compounds of the plant *Cymbopogon schoenanthus* (L.) Spreng was performed according to according to **Sharma *et al*. (2008)**. A weight of 100 g of the dried plant was ground and then macerated in 1000 mL of methanol (85%) under agitation for 5 days at room temperature (ratio of 1:10 w/v). Using a Whatman filter paper, the mixture was filtered and then evaporated to eliminate methanol using a rotary evaporator (Heidolph) at 40°C and 150 mmHg. The acquired crude extract, designated as crude extract (CrE), was subsequently dried in an oven at 40°C. The crude extract was subjected to fractionation using liquid-liquid extraction **(Markham, 1982)**. The introduction of the chosen solvents is to be added in order of increasing polarity. The crude extract was solubilized in 100 mL of hexane and then transferred to a separating funnel, where it was left to stand. After the separation

occurred, the base of the separating funnel was opened to collect the aqueous layer, and the remaining content was poured into a container. The same volume of hexane and method was repeated twice more. Furthermore, a vaporization process is carried out to obtain a hexane extract (HE). An equal volume of chloroform was added to the obtained aqueous layer, shaken, and then allowed to settle to obtain the chloroform extract (CE). The same cycle was performed to obtain an ethyl acetate extract (EAE), and the remaining aqueous layer is considered the aqueous extract (AE). All extracts were placed in the oven at 40°C to eliminate any residual solvent and then stored at 4°C until use.

3.2. Yield calculation

The yield was calculated as the ratio between the mass of the extracts and the mass of the plant material used multiplied by 100, using the following formula:

Y (%) = [(M1–M2) /M3] x 100
Y : Yield
M1 : Weight of balloon after evaporation.
M2 : Weight of empty balloon.
M3 : Weight of starting plant material.

3.3. Phytochemical characterization

3.3.1. Determination of total polyphenolic content

The dosage of total polyphenolic content (TPC) was performed using Folin-Ciocalteu's phenol reagent technique, as mentioned by **Aouachria *et al.* (2017)**. The reagent consists of phosphotungstic acid in addition to phosphomolybdic acid, which gives it its yellow color. During the oxidation of polyphenols, the Folin-ciocalteu's phenol reagent is reduced to a complex consisting of tungsten oxide and molybdenum of a blue color. A volume of 1 mL of 10 times diluted Folin was added to 200 µL of each extract or gallic acid standard, then incubated for 4 minutes at room temperature. A volume of 800 µL of sodium carbonate (7.5%) was added to the solution, which was then incubated for 2 hours. The absorbance was read at 765 nm against a blank. The total polyphenol content was determined using a regression equation derived from a standard curve created with gallic acid (0-100 µg/mL) and expressed as µg of gallic acid equivalent per milligram of extract (µg GAE/mg Ex).

3.3.2. Determination of total flavonoid content

For the measurement of total flavonoid content (TFC) of extracts of *Cymbopogon schoenanthus* (L.) Spreng used the aluminum trichloride ($AlCl_3$) protocol described by **Djeridane *et al.* (2006)**. This method focuses on the creation of a covalent linkage between $AlCl_3$ and the hydroxyl groups (OH) of flavonoids, leading to the production of a yellow mixture with maximum absorbance at 430 nm. One milliliter (1 mL) of standard quercetin or a sample diluted in methanol is added to 1 mL of an $AlCl_3$ methanolic solution (2%). The absorbance of the resulting solutions is read at 430 nm after incubation at room temperature for 10 minutes. The total flavonoid content was determined by a calibration curve formed with quercetin (0-30 µg/mL) and calculated in µg of quercetin per mg equivalent extract (µg QE/mg Ex).

3.4. *In vitro* evaluation of antioxidant activity

3.4.1. Total antioxidant capacity

Total antioxidant capacity (TAC) was determined using the phosphomolybdic protocol described by **Prieto *et al.* (1999)**. This protocol focuses on reducing molybdenum as molybdate ions (MnO_4^{2-}) to molybdenum (MnO^{2+}) under the influence of extracts, forming a green complex at acidic pH. A volume of 3 mL of reagent mixture (0.6M H_2SO_4, 28 mM Na_2HPO_4 and 4 mM ammonium molybdate) was added to 0.3 mL of each extract at varying concentrations. The tubes were incubated for 90 min in a water bath at 95°C, and the absorbance was measured at 695 nm with a reference blank, where the extract was replaced with methanol. The calculation of the total antioxidant capacity is determined using the regression formula of the standard curve represented by ascorbic acid (0-250 µg/mL), and is reported in micrograms of ascorbic acid equivalent per milligram of extract (µg AAE/mg Ex).

3.4.2. DPPH radical scavenging assay

In the presence of proton donors, the reactive radical of the violet-colored DPPH (2,2-Diphenyl-1-picrylhydrazyl) changes to a yellow-colored DPPH upon reduction. The intensity of the coloration is inversely proportional to the anti-radical activity, also known as the scavenger effect, which is an indirect method for determining proton donors in natural compounds. The anti-radical power test was conducted using the method described by **Li *et al.* (2009)**. A freshly prepared solution of 1 mL of DPPH

(0.1 mM) was mixed with 3 mL of ascorbic acid or extract solutions of different concentrations and then incubated for 30 minutes in darkness at room temperature. The absorbance was read at 517 nm relative to a blank, where the extract was substituted with methanol. The calculation of the inhibition percentage was calculated as follows:

I (%) = ((Ac-Ae)/Ac) x 100

I: the percentage of inhibition.
Ac: absorbance of negative control (in the absence of the extracts).
Ae: absorbance of the DPPH-extract solution.

The concentration required for 50% inhibition of DPPH (IC_{50}) for each extract is calculated and expressed in µg/mL, using inhibition curves as a function of concentration, and then compared to BHT.

3.4.3. Cation radical reduction test ABTS$^{\bullet+}$

The ABTS$^{\bullet+}$ (2,2'-azinobis-3-ethylbenzothiazoline-6-sulfonic acid) trapping or cation radical reduction test relies on the reduction of the pre-formed radical monocation (ABTS$^{\bullet+}$) during interaction with potentially hydrogen-donating antioxidants at 734 nm. The decolorization of the solution results from the reduction of the ABTS$^{\bullet+}$ radical form **(Lendoye *et al*., 2022)**. The method of **Re *et al*. (1999)** was applied to this essay. The solution of the cationic radical (ABTS$^{\bullet+}$) was prepared by adding 2.45 mM ABTS to 7 mM potassium persulfate and incubating it for 16 hours in the absence of light. After incubation, the solution was diluted with deionized water to achieve an absorbance of 0.7 ± 0.05 at 734 nm. A volume of 0.1 mL of each extract was added to 2.9 mL of a freshly prepared solution of (ABTS$^{\bullet+}$), and the absorbance was measured after 7 minutes of incubation at room temperature. The inhibitory percentage and IC_{50} of each extract were calculated and expressed in µg/mL, and BHT was used as a standard antioxidant.

3.4.4. Ferric reducing antioxidant power FRAP

The reduction of the complex of ferric ions (Fe3+)-ligand to the intensely blue ferrous complex (Fe2+) using antioxidants is a typical method measured by the FRAP test. An increase in absorbance at 593 nm is evidence of antioxidant activity **(Munteanu & Apetrei, 2021)**. **Oyaizu's (1986)** method was used to determine the ferric-reducing antioxidant power. 2.5mL of each extract or the standard ascorbic acid at different

concentrations is combined with 2.5mL of phosphate buffer solution (0.2M, pH 6.6) additionally to 2.5mL of (1%) ($K_3Fe(CN)_6$) solution, the mixture was set for incubation for 20 minutes at 50°C in a water bath (MEMMERT). A volume of 2.5mL of (10%) (TCA) was introduced as a way to block the reaction. Moreover, 2.5 mL of distilled water and 0.5 mL of 0.1% aqueous $FeCl_3$ solution were added. The absorbance was measured at 700 nm against a blank, where the extract was replaced with methanol. The $A_{0.5}$ of the extracts was calculated by interpreting the linear regression curve.

3.5. Evaluation of antibacterial activity

To evaluate the antibacterial activity of this plant, a disc diffusion method was carried out **(Bereksi *et al.,* 2018)**. Starting with the preparation of bacteria from a young culture (18 to 24 hours old) grown on a Nutrient Agar (NA) medium. The cell density of these inocula was adjusted by dilution using sterile saline solution to achieve an optical density (OD) between 0.08 and 0.1 (approximately 10^8 CFU/mL) at a wavelength of 600nm **(Victor & Gaël, 2019)**. Bacterial inocula were incorporated into Mueller-Hinton agar at a 1% (v/v) concentration (1.5 mL per 150 mL medium). Various concentrations of (200 µg/mL of CrE/AE; 100 µg/mL of HE; 50 µg/mL of EAE) were tested. Sterile 6 mm Whatman No. 3 discs were impregnated with 10 µL of each extract and aseptically deposited on the agar surface. Positive control consisted of commercial antibiotic discs containing gentamicin (10 µg/disc), while negative controls received 10 µL of DMSO. The plates were left at 4°C for 2 h to allow pre-diffusion of bioactive substances. Results were read after incubation at 37°C for 24 to 48 hours. Any growth inhibition zones around the discs were measured in millimeters (mm).

3.6. Acute oral toxicity of crude extract

According to OCDE Guideline No. 423 for testing chemicals, which was adopted on December 17, 2001, the acute oral toxicity test was assessed by evaluating it based on the limit test at 2000 mg/kg body weight (**OCDE, 2001**). The test was carried out on nine female *Swiss* albino mice, which were divided based on weight homogeneity after being fasted for 4 hours to prevent any digestive food interactions (Appendice 2). The first three mice, comprising the control group, received physiological water (NaCl 0.9%). In comparison, the two other groups of three mice each received a

unique dose of the crude extract of *Cymbopogon schoenanthus* (L.) Spreng at 2000 mg/kg body weight of 0.5 mL/100g.

3.6.1. Observation

The animals were individually observed after administration, with particular emphasis on the first 4 h, and daily every 12 h, for 14 days. Then, they were observed for 14 days to report any mouse behavior, symptoms, or mortality. During this period, all behavioral and symptomatic variations that were observed with the naked eye have been documented. The main clinical signs recorded are external physical appearance (appearance and hair loss), as well as measurable clinical signs (changes in cardiac and respiratory, abdominal contraction, diarrhea, sleep, and coma) and the change of behavior (posture, scratching, aggressiveness, sensitivity to noise and light and hypersalivation, etc.).

3.6.2. Evolution of body weight

The mice used in this study had their body weight measured before the administration of the extract, 7 days later, and 14 days after the start of the acute toxicity test.

3.6.3. Plasma preparation and biochemical analysis

On the 14th day of the experiment, the mice used were deprived of food for 4 hours before being sacrificed. After collecting the blood in heparinized tubes, it was subjected to centrifugation at 3000 rpm for 10 minutes at 4°C. The plasma obtained is aliquoted and kept under cold conditions to measure glycemia, urea, creatinine, glutamate oxaloacetate transaminase (AST), glutamate pyruvate transaminase (ALT), alkaline phosphatase (ALP), total cholesterol (TC), and triglycerides (TG) using commercial kits (Biomaghreb, Tunisia) (Appendice 3).

3.6.4. Relative organ masses

The kidneys and liver of the mice used were quickly removed and weighed by reporting the absolute organ weight and body weight of the animal on the day of sacrifice; the relative weight of the organs of each mouse was calculated using the following the formula **(Baali *et al.*, 2024)**:

Rw = (Ow / Bw) × 1000

Rw: relative weight of organ (g/kg).

Ow: organ weight (g).

Bw: mouse body weight (g).

3.6.5. Histological examination

Histological examinations were conducted on liver and kidney samples that had been fixed in 10% formalin and embedded in paraffin. Tissue sections of 5 µm thickness were prepared using a rotary microtome (Leica, Allemagne) and then stained with hematoxylin and eosin (H&E) following the protocol described by **Marque (2010)**. The staining process included deparaffinization, hydration, staining, rinsing, and clearing with xylene. After staining, the sections were mounted on glass slides and analyzed under a light microscope to identify any tissue alterations.

3.7. Analgesic activity of crude extract

The method described by **Koster *et al.* (1959)** was used to induce abdominal contractions by injecting acetic acid. This approach evaluates non-morphine analgesic effects. Four groups of five female rats received oral administration of the crude extract of *Cymbopogon schoenanthus* (L.) Spreng (250 and 500 mg/kg bw), Sodium diclofenac (50 mg/kg bw, reference drug) and 1% Tween 40 in physiological saline (5 mL/kg, vehicle control). One-hour post-administration, each mouse received an intraperitoneal injection of 0.6% acetic acid. After a 5-minute latency period, abdominal writhes were counted for 15 min (Appendice 2). Analgesic efficacy was calculated using the following formula:

% Inhibition = [(Nc - Nt)/Nc] × 100

Nc: Number of writhing counts in the control group.

Nt: Number of writhing counts in the test group.

3.8. Statistical analysis

The ethnobotanical data were entered into an Excel spreadsheet (version 2016) and subjected to comprehensive analysis using descriptive statistical methods, including percentages, proportions, and frequencies. The results were analyzed using GraphPad Prism 7 software. The findings were presented as average values ($n=3$) ± SD for *in vitro* experiments and acute oral toxicity studies and as average values ($n=6$) ± Standard Error of Mean (SEM) for *in vivo* experiments. Statistical analysis of data was accomplished using one-way analysis of variance (ANOVA), "Dunnett's multiple comparison test" was used to compare with the control group. Furthermore, "Tukey's multiple comparisons test" was used to determine significant differences between groups. Differences were considered statistically significant at $p < 0.05$.

Results and Discussion

1. Ethnobotanical study

1.1. Informant profile

1.1.1. Gender

The data collected from the ethnobotanical study showed a significant male predominance (89.36%) (Table 2) among medicinal plant knowledge holders and only 10.63% where females. The reason behind male dominance may reflect cultural norms that position men as the primary keepers of herbal knowledge, possibly due to their roles as professional herborists and social limitations on women's public participation in traditional medicine.

Table 2. Sociodemographic characteristics of the participants.

	Category	Effective	Rate (%)
Gender	Male	42	89.36
	Female	05	10.63
Age range	<20	00	00
	20-30	03	6.38
	31-40	03	6.38
	41-50	19	40.42
	51-60	13	27.65
	>60	09	19.14
Education level	Illiterate	10	21.27
	Primary level	11	23.40
	Secondary level	21	44.68
	University	5	10.63
Type of profession	Herborist	40	85.10
	Townsfolk	06	12.76
	Others	01	2.12
The use of medicinal plants	Ancestral	31	65.95
	Training	07	14.89
	Both	09	19.14

Similar to our findings, **Ahmad *et al*. (2014)**, **Chekole, (2017)**, **Hu *et al*. (2020)**, and **Tahir *et al*. (2023)** in Pakistan, Northern Ethiopia, China, and Northeastern Ethiopia, respectively, found that men were more likely to be acknowledged as traditional healers and plant specialists. Conversely, **Polat (2018)** and **Alqethami *et al*. (2020)** found that females are more involved in traditional medicine due to their roles in family health care and food preparation.

1.1.2. Age range

The use of medicinal plants in the region studied is widespread among all age groups, with a predominance of people of age (41-50) with 40.42% followed by (51-60), (>60), (31-40), (20-

30) with 27.65%, 9.14%, 6.38%, respectively (Table 2). The results found by **Emre *et al.* (2021)** confirm that traditional knowledge is primarily retained among older people. The majority of medicinal plant users were older individuals. Meanwhile, the younger demographic showed limited interest in traditional phytotherapy, indicating a potential decline in the transmission of this knowledge to future generations **(Benaiche *et al*., 2019; Firehun Lulesa *et al*., 2025)**.

1.1.3. Education level

The educational backgrounds of the participants differ, with 10.63% holding a university degree, 44.68% having a secondary education, 23.40% having a primary education, and 21.27% being illiterate (Table 2). This distribution indicates that traditional medical knowledge is maintained across a range of educational backgrounds and extends beyond formal education levels. A study conducted by **Tamene *et al.* (2023)** found that greater exposure to modern education was associated with a decline in the use and knowledge of traditional medicinal practices as individuals advanced in formal education.

1.1.4. Type of profession

The overwhelming majority of participants are herborists (85.10%), followed by minimal representation from townsfolk (12.76%) and others who occupy various professions (2.12%) (Table 2), conversely to a study from moroco where homemakers comprised 37% of medicinal plant users, peasants 20%, officials 15%, and only 6% for herbalists. The majority of participants acquired their knowledge from herbalists, indicating a reliance on professional sources for ethnobotanical information **(Kachmar *et al*., 2021)**. This distribution may be due to the influence of lifestyle and occupation on the acquisition and utilization of ethnobotanical knowledge **(Kefifa *et al*., 2019)**.

1.1.5. The use of medicinal plants

Ancestral acquisition of the use of medicinal plants accounts for (65.95%) of knowledge transmission, followed by combined ancestral and formal training (19.14%) and formal training alone (14.89%) (Table 2), indicating that family traditions play a key role in preserving ethnobotanical knowledge. In contrast, formal training reflects the growing interest of people in sharing and protecting this knowledge more widely. Studies conducted by **Constant & Tshisikhawe (2018)** previously found that medicinal plant knowledge is predominantly transmitted vertically within families, emphasizing the pivotal role of the family in knowledge transmission.

1.1.6. Family situation

The ethnobotanical survey conducted in the study area reveals that medicinal plants are used more frequently by married individuals (74.63%) compared to single and widowed individuals (21.64%) and those who are divorced (3.73%), respectively (Figure 3). Numerous studies have found that marital status has a significant influence on ethnobotanical knowledge. According to research, married individuals tend to have more knowledge about medicinal herbs than single individuals do **(Tahir *et al*., 2023; Misganaw *et al*., 2025)**.

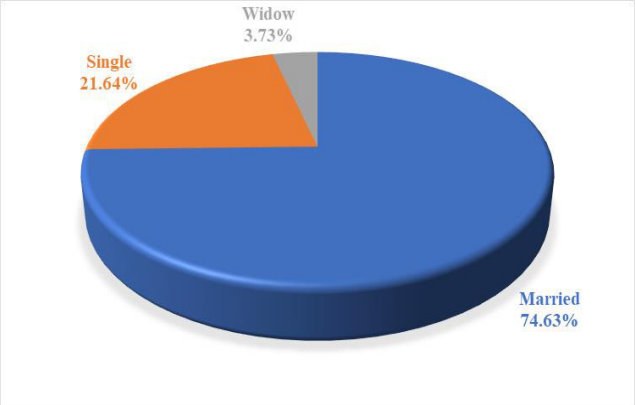

Figure 3. Use of medicinal plants according to family situation.

1.2. Plant profile

1.2.1. Nature of the plant

Among the total number of the plants recorded, 89.71% are wild (spontaneous), while only 8.82% are cultivated (Figure 4). This preference is attributed to their year-round availability, making them more accessible to the local population for medicinal purposes. This finding aligns with the results obtained by **Lazli *et al*. (2019)**, who reported similar reliance on spontaneous medicinal plants in their study.

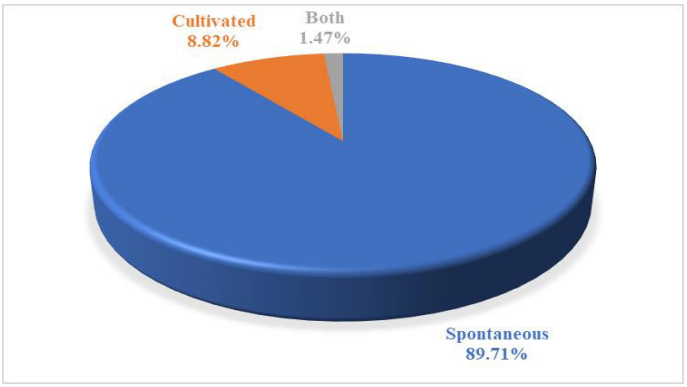

Figure 4. Use of medicinal plants according to the nature of the plant.

1.2.2. Picking season

In the present study, spring was identified as the most common harvesting season for medicinal plants, accounting for 41.94% of cases, followed by summer at 24.52%, and year-round harvesting at 10.32%. This trend is likely attributable to favorable weather conditions and the natural growth cycles of the plants. In contrast, winter and autumn remain the two least favorable seasons for harvesting medicinal plants, with low percentages of 13.55% and 9.68%, respectively (Figure 5). These results are similar to those obtained by **Jalali *et al.* (2024)** in the regions of Semnan Province (Iran), who found that spring is the season with the highest percentage of (66.4%).

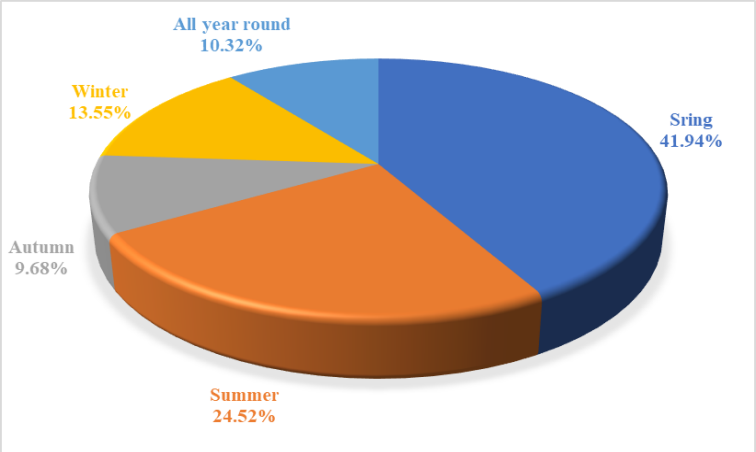

Figure 5. Use of medicinal plants according to the season of harvesting.

1.2.3. Used parts

In traditional medicine, various parts of plants are utilized, including leaves, flowers, roots, fruits, and even the entire plant. In the present study, leaves were found to be the most commonly used part in medicinal plant preparation at (42.64%), followed by the stem and flower (16.24%), the whole plant (6.09%), root (4.57%) and seeds (4.06%) (Figure 6). However, resin and rhizome were the least likely parts involved. A study conducted by **Chaachouay *et al.* (2019)** revealed that among the various parts of medicinal plants used in traditional practices, leaves were the most frequently utilized, representing 44% of the reported applications. This preference is often attributed to the ease of collection and the high concentration of bioactive compounds.

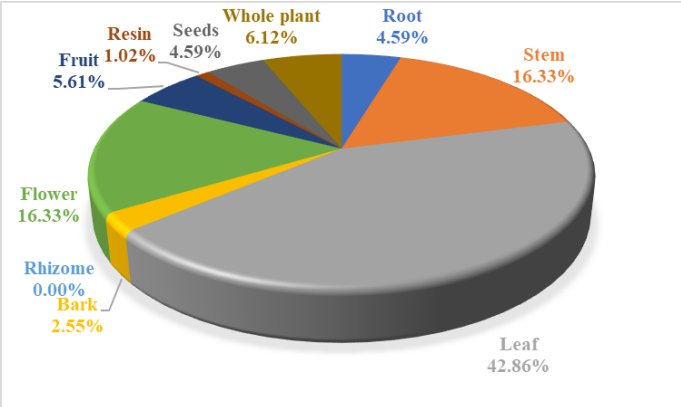

Figure 6. Use of medicinal plants according to the plant part used.

1.2.4. Mode of preparation

To facilitate the administration of medicinal substances, various preparation methods are employed. The infusion was the most used method reported in this research, with a percentage of 61.36%, then powdering and decoction with 22.16% and 9.09%, respectively (Figure 7). The infusion method is considered the most effective technique for preserving the active ingredients of plants, making it the most commonly used method for preparing medicinal plants. The latter was confirmed by numerous studies **(El Finou *et al.*, 2023; Nicerine *et al.*, 2024)**.

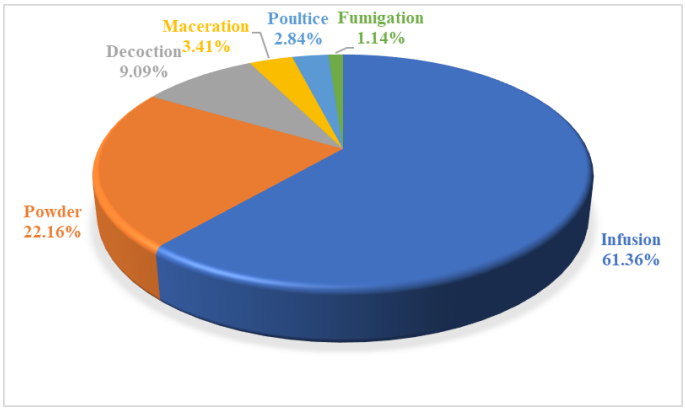

Figure 7. Use of medicinal plants according to the mode of preparation.

1.2.5. Mode of administration

In our study, oral administration emerged as the most prevalent method, accounting for 89.73% of cases, likely due to its simplicity, effectiveness, and rapid action. This was followed by the massage technique at 7.53%, and inhalation at 2.74% (Figure 8). This method aligns with results reported by **Benarba (2016)** and **Lefrioui *et al.* (2024)**, who also found oral administration to be the most common, highlighting a shared reliance on oral remedies due to their ease of use.

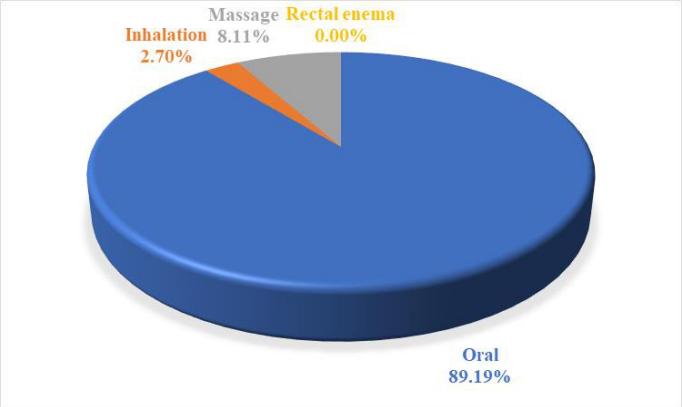

Figure 8. Use of medicinal plants according to the mode of administration.

1.2.6. Used dose

The findings of this study indicate that most medicinal plants are administered in imprecise doses: 50.36% are measured as spoonfuls, 34.31% as handfuls, and 5.84% as a pinch, while only 9.49% are used in precise, standardized amounts (Figure 9). **Ralte *et al.* (2024)** found that based on the patient's age, health, and severity of the condition, the indigenous community establishes dosages, where measurements are frequently made with local units such as pinches, spoons, and cups.

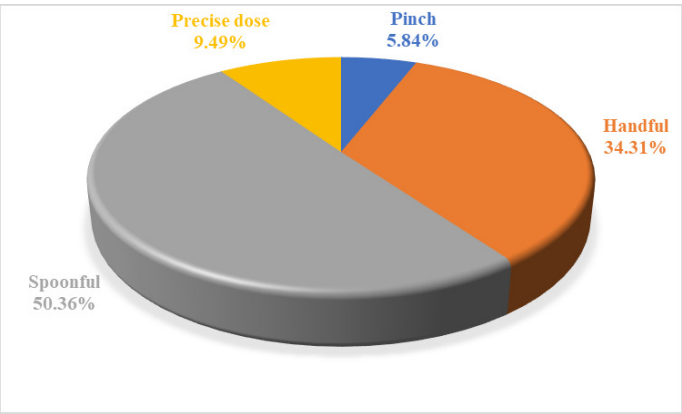

Figure 9. Use of medicinal plants according to the used dose.

1.2.7. Treated disease

According to this ethnobotanical study, the most commonly treated conditions with medicinal plants are digestive, dermatological conditions, diabetes, neurological and genitourinary conditions with percentages of 23.42%, 11.15%, 10.41%, 10.04%, and 9.67%, respectively. Finaly, the rheumatismal diseases (1.49%) and ocular conditions (1.12%) are being the least treated conditions (Figure 10). Many studies in different regions have found digestive conditions to be the highest treated by medicinal plants **(Chermat & Gharzouli, 2015; Benarba *et al.*, 2015; Rhattas *et al.*, 2016; Lazli *et al.*, 2019)**.

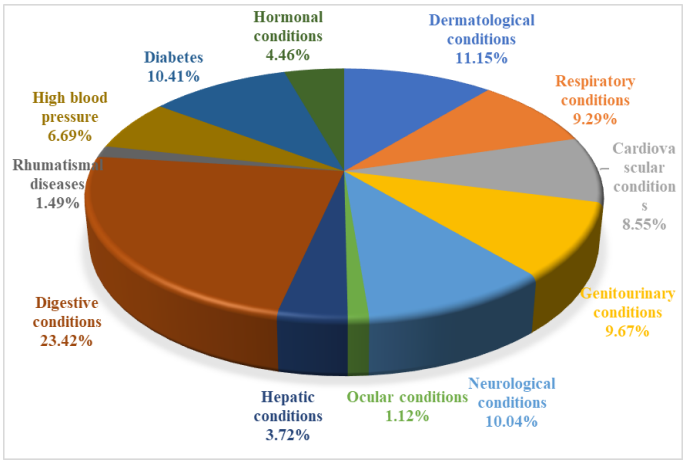

Figure 10. Use of medicinal plants according to the group of diseases treated.

1.2.8. Toxicity

The overwhelming majority of the interviewed people believed that the plants they utilize for medical purposes are safe (94.78%), while just 5.22% of the reported plants possess possible toxicity (Figure 11). This can be a sign of a lack of formal understanding of plant toxicity or a strong conviction in the safety of traditional treatments. A study in Morocco revealed that the majority of users often overlook or are unaware of the potentially toxic effects of the plants they use, highlighting a significant gap between traditional knowledge and toxicological awareness **(Ed-dahmani *et al.*, 2024)**.

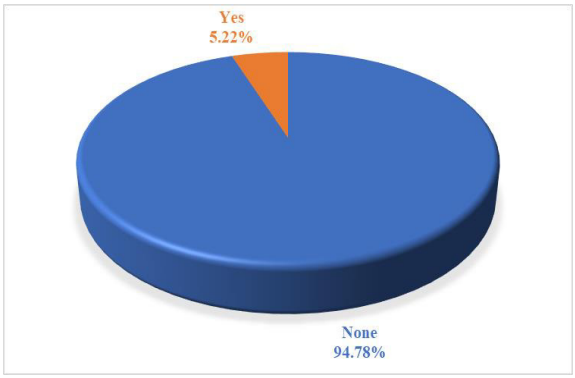

Figure 11. Use of medicinal plants according to toxicity.

1.3. Ethnobotanical inventory of medicinal plants

1.3.1. Inventory of medicinal plants

Our ethnobotanical survey identified 84 medicinal plants and their therapeutic uses, resulting in a systematically documented list (Table 3) of species employed for disease treatment in the study region, presented in alphabetical order. For each plant, we recorded the scientific name, local vernacular name(s), Relative Frequency of Citation (RFC), utilized plant part(s), preparation methods, and associated treated conditions.

Table 3. Inventory of medicinal plants selected for the ethnobotanical study.

Scientific name	RFC	Vernacular name	Used part	Mode of preparation	Treated disease
Atriplex	0.02	El Guttaf	Leaf	Inf	HD, HBP and DM
Acacia raddiana	0.02	Al-Talh	Leaf	Inf	DC, DigC, RC and DM
Ajuga iva	0.02	Shandgora	Leaf, bark, flower	Inf	NC
Alhagi maurorum	0.02	Elakoul	Whole plant	Inf	DC, GUC, RC, NC and DigC
Ammi majus	0.02	Kamon Elbari	Stem, leaf	Inf	RC, DigC and RD
Ammodaucus leucotrichus	0.10	Kamon Elsofi	Leaf, flower, seeds	Inf, pdr	DigC and DM
Anvillea radiata	0.04	Nougd	Leaf, flower	Inf	DM, RC, DigC, HC and CVC
Argania spinosa	0.02	Argan	Leaf, flower, stem	Inf	DigC and DC
Artemisia campestris	0.02	Alala	Leaf, bark, fruit	Inf	DC, NC, HC and DM
Artemisia herba alba	0.08	Chih	Leaf	Inf, pdr, dec, fum	DC, RC, GUC, DigC, HBP and DM
Asphodelus tenuifolius	0.04	Tazia	Root, leaf, flower	Inf, pdr	GUC, DigC and HC
Aster alpirus	0.02	Nojoum	Root, leaf	Inf, dec	GUC
Atriplex halimus	0.02	Getaf maleh	Fruit	Inf, pdr	HC
Bidensaurea	0.02	Hika dahbia	Leaf	Inf	NC
Buninum bulbocastanu	0.04	Targhouda	Leaf, flower	Inf, pdr	HC

Calotropis procera	0.02	El-ajroum	whole plant	Plt	DC
Capparis spinosa	0.02	Kejar	Resin	Inf	DigC and DC
Cartaegus laevigata	0.02	Warak zaaror	Root, leaf, bark	Inf	RC, DigC and HBP
Centaurium erythraea	0.02	Mararat Al-Hanash	Leaf	Inf	DigC and DM
Ceratonia siliqua	0.02	Kharoub	Stem, leaf, flower	Inf	CVC and DigC
Cinnamomun verum	0.02	Karfa	Leaf, bark, fruit	Inf, dec, pdr	DC, RC, DigC, CVC and HC
Citrullus colocynthis	0.02	Hantal	Bark	Inf	DC, DigC, RD and DM
Crocus sativus	0.02	Zaafran	Root, leaf	Inf	CVC, NC and OC
Cucumis myriocaprus	0.02	Fagous El-hamir	Flower	Inf, dec	DC, RC, NC and DigC
Cuminum cyminum	0.02	Kamoun	Seeds, fruit	inf, pdr, dec, plt	DC, DigC, RC, NC and DM
Curcuma longa	0.04	Kurkum	Whole plant	Inf, pdr	CVC, RD and HBP
Cymbopogon schoenanthus (L.) Spreng	0.34	El-lamad	Root, stem	Inf	GUC and DigC
Cytinus hypocistis	0.02	Doghmous	Airian part	Inf, dec, mac, pdr, plt	DC, RC, DigC, HBP and DM
Dactyloctenium aegyptium	002	Najem	Stem	Inf	GUC
Deverra triradiata	0.02	Echbet gezah	Root	Inf	GUC and HBP
Ephedra sinicaletu	0.04	Aalanda	Stem, leaf	Inf, pdr	Cancer
Equisetum arvense	0.02	Danab El-lkhail	Stem	Inf, dec	DC, OC and CVC

Erica arborea	0.02	Azhar Al-Khilanaj	Stem	Inf	GUC
Foeniculm vulgare	0.02	El-shamer	Flower	Inf	DigC
Haloxylon salicornicum	0.02	Rameth	Seeds, fruit	Inf	DM, HBP, DC and DigC
Henophyton deserti	0.02	Hennat Al-Ibil	Leaf	Inf	CVC
Herniaria hirsuta	0.04	Ftatet El-hajar	Whole plant	Inf	GUC
Hibiscus sabdariffa	0.04	Carcadine	Stem, leaf, flower	Inf	DC, HBP and DM
Hypericum perforatum	0.02	Ushbat El-qedissine	Flower	Inf	NC and DigC
Lavendula officinalis	0.04	El-khouzama	Leaf, flower	Inf, mac	DC, RC, NC, DigC and HC
Lupinus albus	0.04	Tourmous mor	Flower	Pdr	DM
Matricaria chamomila	0.02	Babounj	Seeds	Inf	NC
Melissa officinalis	0.02	Turanjan	Flower	Inf	NC and DigC
Mentha pulegium	0.02	El-fliou	Leaf	Inf	RC and DigC
Merrulium vulgare	0.02	El-mariote	Stem, leaf	Inf, plt, fum	DigC
Moricandia arvensis	0.02	Ades elma	Leaf	Inf	Weight loss
Moringa oleifera	0.02	Moringa	Leaf, flower, fruit	Pdr	DM
Myrtus communis	0.02	Kamam	Leaf	Inf, mac, pdr	DC, NC and DigC
Nepenthes	0.04	Nabita	Stem, leaf, flower	Inf	CVC, DIigC and HepC
Nerium oleander	0.02	Dafla	Leaf	pdr, dec	DC, RC, CVC and DigC
Ocimum basilicum	0.02	Rayhan	Leaf	Inf	HBP

Opuntia ficusindica	0.02	Eltin shawki	Leaf	Inf, pdr	GUC, CVC, DigC and DM
Origanum majorana	0.04	Bardaqoush	Flower, fruit	Inf, pdr	HC
Peganum harmala	0.02	Harmel	Leaf	Inf, dec	DC, CVC, RC, DigC, GUC, HepC, RD and NC
Pelargonium graveolens	0.02	Atercha	Seeds, stem, leaf	Inf	NC and DigC
Pergularia tomentosa	0.02	Kelka	Stem	Inf, dec, plt	DC, RC, HC and DigC
Pimpinella anisum	0.02	Yansoun	Stem, leaf, flower	Inf, dec	NC, HC and DigC
Pistacia atlantica	0.02	Al-Batmah	Leaf, seeds	Dec	RC and GUC
Plantago ovata	0.04	Lsan El-hamel	Leaf, fruit, resin	Inf, dec	DC, RC, HBP and DM
Propolis	0.02	Oukbour	Leaf	Pdr	DigC and DC
Psidium guajava	0.06	Waraqat Al-Jawafa	Whole plant	Inf	RC
Rosmarinus officinalis	0.12	Iklil El-jabel	Fruit	Inf, dec, pdr	NC, DIigC and RD
Ruta tuberculata	0.02	Fijel	Stem, leaf	Inf, dec, mac, pdr	NC and DigC
Salvia officinalis	0.021	Miramia	Stem, leaf, whole plant	Inf	HBP
Santolina anthemoides	0.02	Gartofa	Root	Inf	NC and DigC
Senna alexandrina	0.10	Senan maki	Leaf, flower	Inf	DM
Silybum marianum	0.02	Chouk El-Jamel	Leaf	Inf, pdr	HepC, CVC, DigC, RC, GUC, HBP and DM
Solanum villosum	0.02	Eneb El-dib	Seeds, leaf, flower	Inf	RC and DigC
Stevia rebaudiana	0.02	Stivia	Stem, leaf, flower	Inf	DC, NR, DigC, HBP and DM

Stigma maydis	0.02	Harir eldurah	Leaf	Inf	GUC
Syzygium aromaticum	004	Al-qurunful	Flower	Inf	DC, CVC, DigC and DM
Teucrium polium	0.02	Jaada	Fruit	Inf, mac	DC and DigC
Thuja occidentalis	0.06	El-afsa	Leaf,flower	Inf	DigC
Thymus vulgaris	0.02	Zaatar	Leaf	Inf	DC, RC, DigC and HBP
Triticum aestivum	0.02	Ushbat El-qamh	Stem, leaf, flower	Pdr	DigC, HR and DM
Tuber magnatum	0.02	El-kamaa	Stem	Inf	DigC and OC
Ulmus minor	0.02	Drdar El-ouyoun	Fruit	Inf	DigC, DM and RD
Umbilicus intermedius	0.06	El-soura	Leaf	Pdr	NC and DigC
Urtica dioica	0.02	Houraiq	Leaf, flower	Inf	GUC, HBP and DM
Vachellia nilotica	0.02	Samaq Al-arabi	Stem, leaf, whole plant	Pdr	GUC
valeriana officinalis	0.02	Sunbul	Leaf, flower	Inf	NC
Withania somnifera	0.02	Ashwagandha	Leaf	Pdr	HC
Ziziphus spina-christi	0.02	Nabaq	Stem	Pdr	DigC
Zygophylum album	0.02	El-Aqqah	Fruit	Pdr	DC

Inf : infusion ; Pdr: powder; Plt: poultice; Mac: maceration; Dec: decoction; Fum: fumigation; DC: dermatological conditions; RC: respiratory conditions; CVC: cardiovascular conditions; GUC: genitourinary conditions; NC: neurological conditions; OC: ocular conditions; HepC: hepatic conditions; DigC: digestive conditions; HC: hormonal conditions; RD: rheumatismal diseases ; DM : diabetes mellitus.

Our results demonstrated that *Cymbopogon schoenanthus* (L.) Spreng. was the most traditionally utilized species (RFC=0.34), followed by *Rosmarinus officinalis* L. (RFC=0.12) and *Senna alexandrina* Mill. (RFC=0.10), making them the most used species in the studied area.

The diversity of medicinal plant inventories varies across studies, as demonstrated by the differences between our findings and those of **Maamar Sameut *et al*. (2020)**. In fact, the most dominant plant family differed from one ethnobotanical survey to another. This variation in results is influenced by geographical differences in the study areas, as well as by the distinct cultural practices and local flora of each region.

2. Phytochemical study

2.1. Extraction yield

Extraction represents the critical first step in recovering and isolating bioactive phytochemicals. In this study, we employed maceration for the crude extract (CrE) preparation, followed by fractionation to separate the plant extract into distinct chemical fractions. Solvents should be introduced in order to increase polarity to obtain extracts enriched with target molecules.

The extraction yields of the studied plant are presented in Table 4.

Table 4. Extraction yield and content of polyphenols and flavonoids in *Cymbopogon schoenanthus* (L.) Spreng. extracts.

Extracts	Yield %	TPC µg GAE/mg Ex	TFC µg QE/mg Ex
CrE	7.26^{a}	138.85 ± 4.98^{c}	27.11 ± 1.70^{b}
HE	0.9^{c}	75.91 ± 1.13^{d}	19.46 ± 0.63^{d}
CE	0.1^{e}	228.26 ± 1.30^{b}	8.46 ± 0.32^{e}
EAE	0.2^{d}	322.44 ± 8.26^{a}	52.88 ± 1.42^{a}
AE	4.3^{b}	39.08 ± 0.64^{e}	21.39 ± 0.57^{c}

Values were expressed as means ± SD (*n=3*). CrE: Crude Extract; HE: Hexane Extract; EAE: Ethyl Acetate Extract, CE; Chloroform Extract; AE: Aqueous Extract. Different subscript letter in the same line indicates significant differences ($p\leq0.05$, Tukey's test).

The CrE had the highest yield (7.26%) followed by the AE (4.3%) likely due to methanol's and water high polarity and HE, chloroform extract (CE) and Ethyl acetate extract (EAE) extracts yielded very little of (0.9, 0.1 and 0.2%) consistent with their non-polar nature, which limits the extraction of polar polyphenols.

Variations in extraction yields may be attributed to solvent polarity, plant collection source, harvest period, drying duration, and extraction methodology. These factors directly influence phenolic compound yields **(Zhang *et al*., 2018)**.

2.2. Total polyphenolic content

Polyphenols have been the focus of much research nowadays, as they play defense agents against physiological and environmental factors due to their chemical and biological activities **(Rasouli *et al*., 2017)**.

The TPC of the extracts of *Cymbopogon schoenanthus* (L.) Spreng was determined using Folin-ciocalteu's phenol reagent method mentioned by **Aouachria *et al*. (2017)**, which focuses on the chemical reduction of Folin reagent. The total polyphenol content was estimated using the regression equation of the calibration range (y= ax+b) established with gallic acid (Figure 12) and expressed in µg of gallic acid equivalent per milligram of extract (µg GAE/mg Ex).

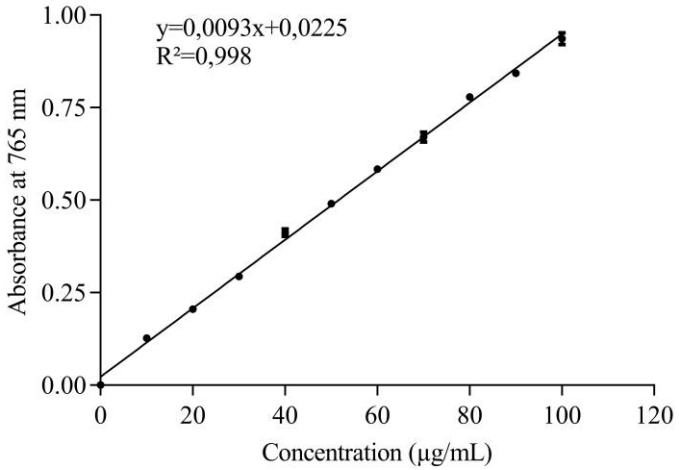

Figure 12. Gallic acid calibration curve. Each value represents the mean ± SD (*n=3*).

According to the results represented in Table 4, a variability amid the different extracts was observed regarding the TPC, the CrE was estimated at (138.85±4.98 µg GAE/mg Ex), whereas the EAE recorded the most significant amount among the other extracts with (322.43±8.26 µg GAE/mg Ex), that is may be due to the solvent's moderate polarity which makes it suitable for extracting polyphenolic compounds. Preceded by CE and HE, respectively with (228.26±1.30 µg GAE/mg Ex, 75.91±1.13 µg GAE/mg Ex), and the aqueous extract was the lowest (39.08±0.64 µg GAE/mg Ex).

Both **Benhelima *et al.* (2020)** and **Ali *et al.* (2022)** previous studies were conducted on *Cymbopogon schoenanthus* (L.) Spreng crude extract, aiming to quantify the TPC, their results showed a lower content than ours with (03.59 ± 0.10 µg GAE/mg Ex, 15.09 ± 0.88 µg GAE/mg Ex) respectively. Meanwhile, the results of the aqueous extract registered by **Najjaa *et al.* (2020)** yielded a higher amount than our extract with (128.63±0.12 µg GAE/mg Ex).

Many researchers believe that various factors contribute to the polyphenolic content of plants, including water, air, soil, extraction methods, and species diversity **(Zargoosh *et al.*, 2019)**. At the same time, **Złotek *et al.* (2016)** suggest that the structure of polyphenols and their solubility in solvents of different polarities could impact the extraction yield from the plant.

2.3. Total flavonoid content

Given the crucial role flavonoids play in a wide range of biological activities, the quantification of TFC was carried out using the methodology described by **Djeridane *et al.* (2006)**. The latter involves the formation of a covalent bond between the flavonoid compounds present in the plant extracts and aluminum trichloride. The total flavonoid content was determined using a calibration curve (y = ax + b) established with quercetin and calculated in micrograms of quercetin per milligram equivalent extract (µg QE/mg Ex). The results of total flavonoid content are represented in Figure 13.

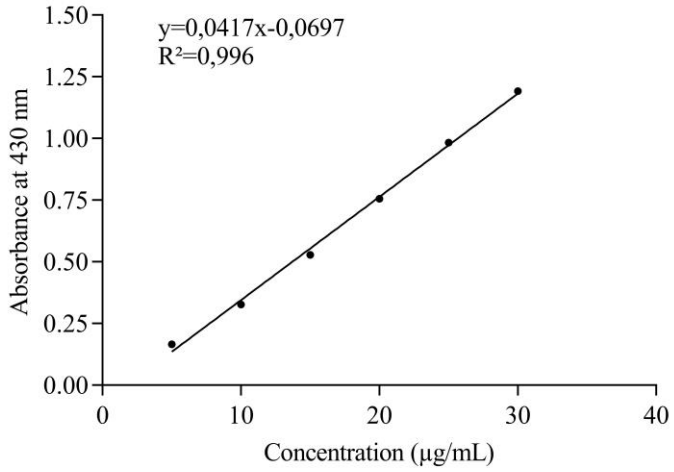

Figure 13. Quercetin calibration curve. Each value represents the mean ± SD (*n=3*).

As Table 4 shows, the content of flavonoids in the crude CrE (27.11±1.70 µg QE/mg Ex) is superior to the results found by **Ali *et al.* (2022)**, which was estimated at (3.07 ± 0.08 µg QE/mg EX). A significant difference was shown among the extracts obtained from fractionation where the EAE held the highest amount (52.88±1.42 µg QE/mg Ex), followed

by HE (19.46±0.63 µg QE/mg Ex). At the same time, CE contained the lowest amount (8.46±0.32 µg QE/mg Ex), which suggests the possibility that the fractionation solvent may influence the total flavonoid content.

In our results, the total phenolic content was found to be more abundant than the total flavonoid content, suggesting the presence of non-flavonoid compounds in our extracts.

3. The *in vitro* evaluation of antioxidant activity

3.1. Total antioxidant capacity

Total antioxidant capacity (TAC) was evaluated using the method described by **Prieto *et al.* (1999)**, which focuses on the reduction of molybdenum in the form of molybdate ions (MnO42-) to molybdenum (MnO2+) in the presence of extracts, thereby forming a green complex at acidic pH.

Quantification was performed using a linear regression model (y = ax + b) based on an ascorbic acid standard curve (Figure 14).

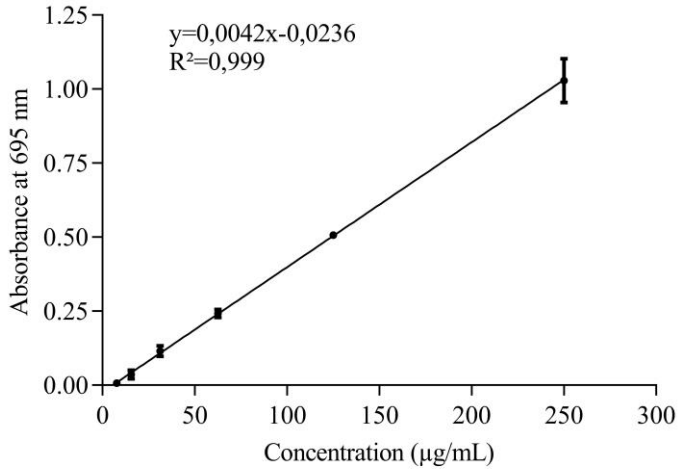

Figure 14. Ascorbic acid calibration curve. Each value represents the mean ± SD (*n=3*).

Results are expressed as ascorbic acid equivalents (AAE) per milligram of extract (µg AAE/mg extract) (Figure 15).

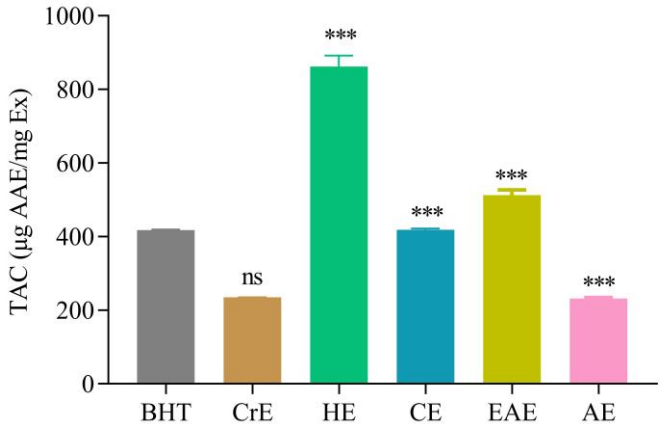

Figure 15. Total antioxidant activity of *Cymbopogon schoenanthus* (L.) *Spreng.* Extracts and BHT. Values were expressed as means ± SD (*n=3*). CrE: Crude Extract; HE: Hexane Extract; EAE: Ethyl Acetate Extract, CE; Chloroform Extract; AE: Aqueous Extract. ns: $p > 0,05$, ***: $p \leq 0,001$ ($p \leq 0.05$, Dunnett's test).

Quantification of total antioxidant capacity (Figure 15) revealed significantly higher values for HE (862.09 ± 29.93 µg AAE/mg) and EAE (513.26 ± 13.81 µg AAE/mg) compared to the BHT control (418.00 ± 0.75 µg AAE/mg) ($p \leq 0,001$), followed by the CE, CrE and AE, respectively (419.00 ± 1.93, 305.70 ± 3.16 and 232.30 ± 1.38 µg AAE/mg).

To our knowledge, no previous studies have investigated the total antioxidant activity of *C. schoenanthus* extracts. Therefore, a direct comparison of our results with prior work is not feasible. The findings highlight HE and EAE as most promising in their TAC potentially due to their low to moderate polarity in extracting antioxidants **(Dai & Mumper, 2010)**.

3.2. DPPH scavenging assay

The 2,2-diphenyl-1-picrylhydrazyl (DPPH**)** radical scavenging assay is a common technique that demonstrates a clear advantage over other methods for determining the antioxidant activity. It is considered a quick, undemanding, and reasonable method for evaluating the radical scavenging activity of antioxidants **(Silva *et al.*, 2024)**.

The percentage of inhibition (IP) of different extracts, as well as the standard BHT, was determined by measuring the absorbance at 517 nm (Figure 16).

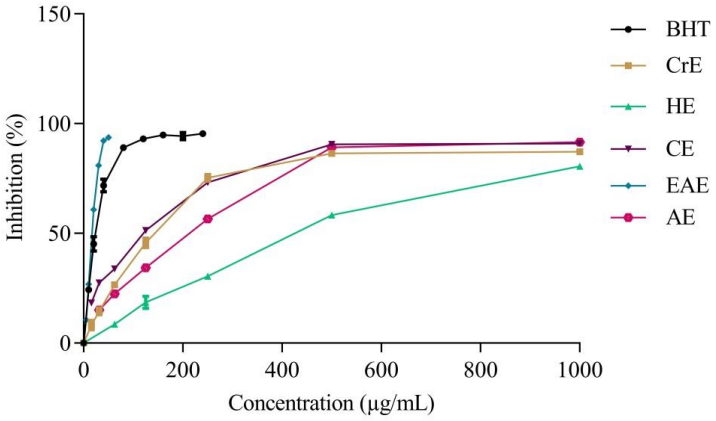

Figure 16. Anti-free radical activity of DPPH radical of BHT and extracts of *Cymbopogon schoenanthus* (L.) Spreng. Each value represents the mean ± SD (*n=3*).

The representative values of antioxidant effectiveness, expressed by the IC_{50} of the extracts and the reference standard (BHT), are reported in Figure 17.

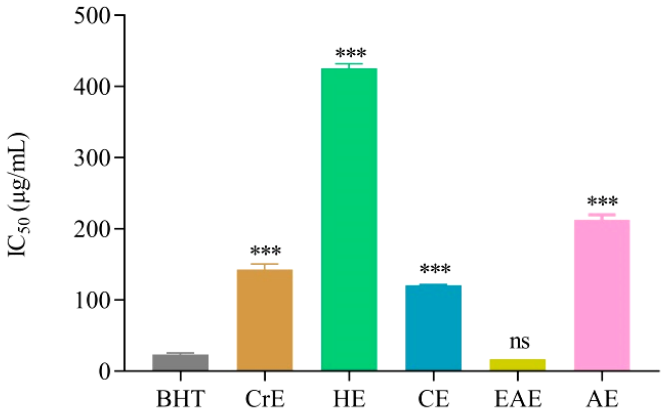

Figure 17. Comparative histogram of the IC_{50} of the scavenger effect of *Cymbopogon schoenanthus* (L.) Spreng. extracts and the standard (BHT) on the DPPH radical. Values were expressed as means ± SD (*n=3*). CrE: Crude Extract; HE: Hexane Extract; EAE: Ethyl Acetate Extract, CE; Chloroform Extract; AE: Aqueous Extract. ns: $p > 0,05$, ***: $p \leq 0,001$ (Dunnett's test).

As Figure 17 represents the IC_{50} of the extracts, the EAE exhibited the highest scavenger activity (16.83±0.03 µg/mL). These results are similar to those of BHT ($p>0.05$), whose IC_{50} is 23.58±0.86 µg/mL. Then, the DPPH scavenging activity decreased in the following order: CE (121±0.60 µg/mL) >CrE (143±4.48 µg/mL) >AE (213.2±3,70 µg/mL) and HE as the lowest antioxidant activity (425.80±3.51 µg/mL), all the previous extracts showed significantly a lower DPPH scavenging activity than that of BHT ($p \leq 0,001$).

The results obtained from the crude extract from our study exhibited a most significant antioxidant activity (143±4.48 µg/mL) compared to the extract reported by **Kadri *et al.* (2021)** with an IC_{50} of 167.92±3.18 µg/mL. However, the work of **Khadri *et al.* (2010)** reported a much lower IC_{50} (17.1±6.3 µg/mL), indicating a higher antioxidant activity. As for the ethyl acetate, hexane, and aqueous extracts of the work of **Khadri *et al.* (2010)** showed an inferior IC50 compared to our extracts with (29.4±7.7, 12.6±3.4 and 53.1±3.3 µg/mL) respectively, demonstrating a strong radical scavenging capacity. According to previous studies on plants, several factors can significantly contribute to the radical scavenging capacity of antioxidant substrates, including the structure, molecular size, polarity, and nature of the molecule **(Xu *et al.*, 2017; Molole *et al.*, 2022)**. Many research studies on plant extracts have shown a strong correlation between the TPC and the radical scavenging capacity used to determine antioxidant activity, indicating that the higher the polyphenol content, the higher the antioxidant capacity **(Dobrinas *et al.*, 2021)**.

3.3. $ABTS^{\bullet+}$ scavenging assay

The ABTS assay is a simple and convenient method for evaluating antioxidant capacity, based on the ability of antioxidants to neutralize the stable $ABTS^{\bullet+}$ radical cation. This radical forms a blue-green chromophore with a maximum absorbance of 734 nm, and its color intensity decreases proportionally in the presence of antioxidant compounds **(Munteanu & Apetrei, 2021)**.

The percentage of inhibition (IP) of different extracts, as well as the standard BHT, was determined by measuring the absorbance at 517 nm (Figure 18).

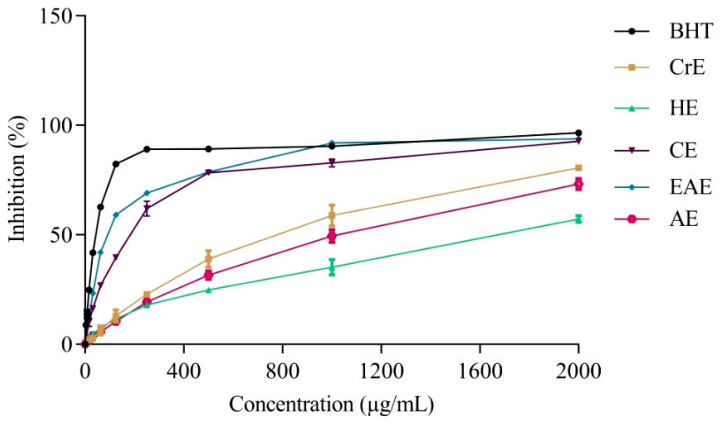

Figure 18. Anti-radical activity of BHT and *Cymbopogon schoenanthus* (L.) Spreng. extracts against the ABTS radical. Each value represents the mean ± SD (*n=3*).

The antioxidant activity of the different extracts is estimated by the inhibitory concentration IC_{50}, obtained from the absorbance values.

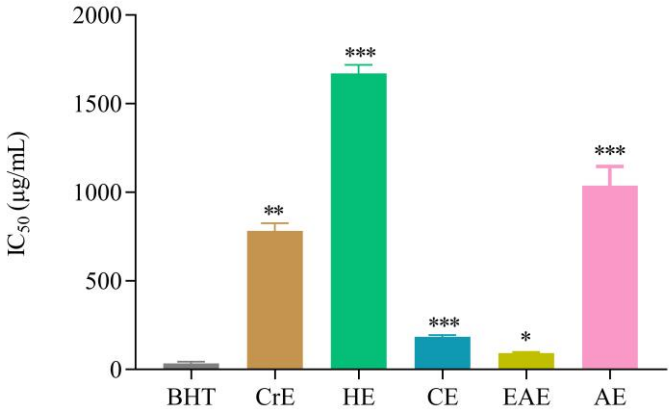

Figure 19. Comparative histogram of the IC_{50} of the scavenger effect of *Cymbopogon schoenanthus* (L.) Spreng. extracts and the standard (BHT) on the ABTS radical. Values were expressed as means ± SD (*n=3*). CrE: Crude Extract; HE: Hexane Extract; EAE: Ethyl Acetate Extract, CE; Chloroform Extract; AE: Aqueous Extract. ns: $p > 0,05$, *$p < 0.05$, **: $p \leq 0,01$, ***: $p \leq 0,001$ (Dunnett's test).

According to Figure 19, among the tested extracts, the ethyl acetate fraction recorded the most potent antioxidant activity with the lowest IC_{50} (92.01±1.12 µg/mL), which was significantly ($p < 0.05$) lower than that of BHT (33.39±4.47 µg/mL). At the same time, the AE and HE exhibited the lowest antioxidant activity, with IC_{50} values of 1671±27.85 and 1037±62.77 µg/mL, respectively.

In the work of **Aous (2015)**, IC_{50} values of the crude extract were obtained from two different regions (919.35±1.9 and 1149.56±2.3 µg/mL), respectively, indicating a lower antioxidant activity compared to the crude extract in our work (783.2±24.45 µg/mL).

In a study conducted by **Neupane & Lamichhane (2020)**, a significant correlation was reported between the TPC and ABTS radical scavenging activity, indicating that higher polyphenolic content corresponds to more potent antioxidant activity.

3.4. Reducing power assay

The reducing properties of *C. schoenanthus* extracts were evaluated using the FRAP assay **(Oyaizu, 1986)**. This method measures the extracts' ability to reduce ferric iron (Fe^{3+}) to ferrous iron (Fe^{2+}) in the presence of an antioxidant. The assay determines an antioxidant's capacity to inhibit the initiation of radical chain reactions.

The results obtained (Figure 20) demonstrate that the ferric-reducing capacity is proportional to both the extract concentrations and the BHT standard.

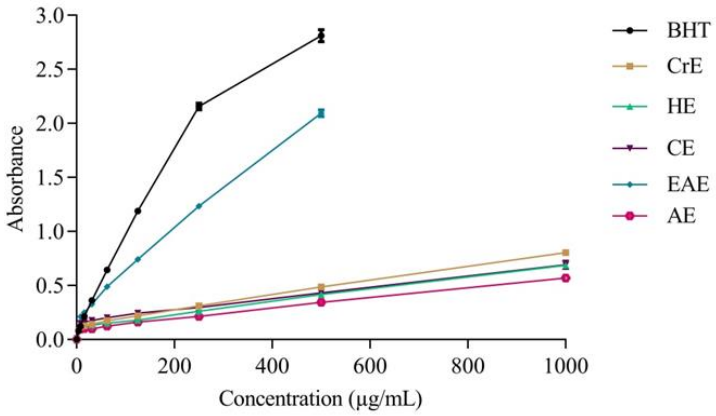

Figure 20. Reducing power at 700 nm of BHT and *Cymbopogon schoenanthus* (L.) Spreng. extracts. Each value represents the mean ± SD (*n=3*)

The $A_{0.5}$ values for the extracts and BHT are shown in Figure 21.

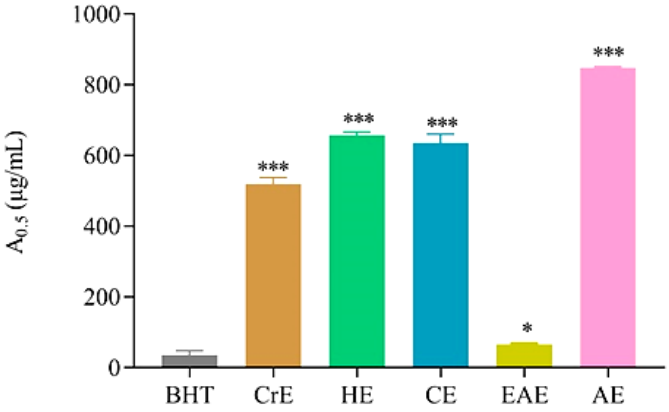

Figure 21. $A_{0.5}$ of *Cymbopogon schoenanthus* (L.) Spreng. extracts and standards. Values were expressed as means ± SD (*n=3*). CrE: Crude Extract; HE: Hexane Extract; EAE: Ethyl Acetate Extract, CE; Chloroform Extract; AE: Aqueous Extract. ns: $p > 0,05$, *p < 0.05, ***: $p \leq 0,001$ (Dunnett's test).

The $A_{0.5}$ values of the extracts reveal that EAE has the strongest reducing power ($A_{0.5}$= 65.66±1.08 µg/mL), which was significantly ($p < 0.0001$) lower than that of BHT (35.09 ± 5.18 µg/mL) ($p \leq 0,001$), while CE, CrE, AE and HE, and show moderate reducing activity (184.1±6.12, 783.2±24.45, 1037±62.77 and 1671±27.85 µg/mL, respectively). However, all extracts were less potent than the BHT reference (35.09 ± 5.18 µg/mL) ($p \leq 0,001$).

Previous work by **Haddouchi *et al*. (2016)** reported limited reducing activity in methanolic extracts (IC_{50} = 56.83 ± 1.53 µg/mL). The variability in ferric ion reduction capacity among plant extracts correlates with the diversity of phenolics. This is because phenolic compounds can effectively neutralize free radicals by forming more stable intermediates **(Abirami *et al*., 2014)**.

4. Antibacterial activity

The antibacterial activity of *Cymbopogon schoenanthus* (L.) Spreng. extracts was evaluated using the disk diffusion method. This method was used to assess the effect of the plant extracts and the reference antibiotic on four bacterial strains: two Gram-positive (*Staphylococcus aureus* and *Bacillus subtilis*) and two Gram-negative (*Pseudomonas aeruginosa* and *Escherichia coli*). The results, expressed as inhibition zone diameters, are presented in Table 5. Note that the inhibition zone diameter includes the diameter of the disks (6 mm).

The tested strains were shown to be very sensitive to extremely sensitive to the reference antibiotic, which is gentamicin, with inhibition diameters ranging from 18.75 to 28.25 mm.

Table 5. Diameter of inhibition zones (mm) of bacterial growth by extracts of *C. schoenanthus* (L.) Spreng. and Gentamicin.

Extract/Strain	CrE (200 mg/mL)	HE (100 mg/mL)	EAE (50 mg/mL)	AE (200 mg/mL)	Gentamicine (10 µg)
B. subtilis	6±0***	6±0***	6±0***	6±0***	28.25±1.06
S. aureus	7.33±0.57***	9.75±1.75***	6±0***	6±0***	18.75±7.35
E. coli	7.5±0.5***	8±0***	9.33±0.57***	6±0***	23.00±0.00
P. aeruginosa	6±0***	6±0***	6±0***	6±0***	19.50±0.70

(6 mm): shows the diameter of the disk. Each value represents the average (n=2) ± SD. ***: $p \leq 0.001$, compared to the positive control (gentamicin), ($p < 0.05$, Dunnet's test).

The assessment of antimicrobial activity against four bacterial strains revealed weak antibacterial effects against both Gram-positive (*Staphylococcus aureus* and *Bacillus subtilis*) and Gram-negative (*Pseudomonas aeruginosa* and *Escherichia coli*) strains, with inhibition zones ranging between 7 and 9.75 mm. However, HE (100 mg/mL) and EAE (50 mg/mL) showed a moderate activity against *S. aureus* and *E. coli*, producing inhibition zones of 9 mm. Studies by **Mokhtar *et al*. (2023)** on the antibacterial activity of the methanolic extract from the same plant against several strains, particularly *Staphylococcus aureus* and *Escherichia coli*, demonstrated inhibition zones of 12 mm for both strains at a concentration

of 100 mg/mL. The antimicrobial activity of plant extracts depends on several factors, including the type of microorganism, the variety of extract, concentration, and chemical composition. Generally, Gram-negative bacteria demonstrate greater resistance than Gram-positive strains, primarily due to their outer membrane structure **(Benhelima *et al*., 2020)**.

5. Acute oral toxicity of crude extract

Acute toxicity is defined by the administration of a single dose of a chemical to an organism, with acute oral toxicity being the most extensively studied method **(Tugcu *et al*., 2023)**. In accordance with **OECD (2001)**, an acute oral toxicity was conducted on female mice in the purpose of ensuring the safety of the crude extract of *Cymbopogon schoenanthus* (L.) Spreng.

5.1. Mortality and general clinical signs

The behavior of the mice was closely monitored throughout the 14 days of the study, no cases of mortality was reported, nor any signs of intoxication caused by a substance present in the crude extract of the plant was observed, indicating that the dose administrated was well tolerated by the subjects, and according to the OECD's Globally Harmonized System (GHS) of classification, the crude extract of *Cymbopogon schoenanthus* (L.) Spreng fall into category 5, with an LD_{50} ranging between 2000 and 5000 mg/kg. Therefore, CrE of *C. schoenanthus* appears to be safe at a dose of 2000 mg/kg b.w., and the LD_{50} was considered higher than 2000 mg/kg b.w. This result indicates that the crude extract of the plant may have the potential to serve as a safe and beneficial pharmacological agent.

5.2. Body weight evolution

Body weight serves as a pivotal indicator of the toxicity of a plant, as studies have demonstrated a correlation between weight loss and the toxic effects of a substance **(Akhigbe, 2014)**. Body weight evolution was assessed throughout the fourteen-day experiment; any changes in the mice's body weight were recorded every 7 days at the same time of day. The results of the changes in body weight of the female mice are presented in Figure 22.

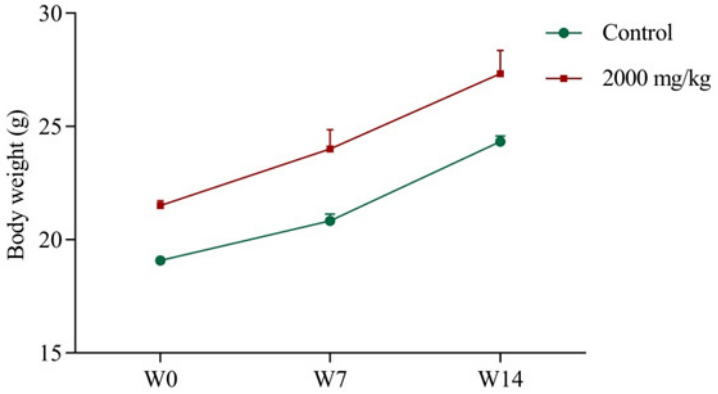

Figure 22. Body weight of mice treated orally with *Cymbopogon schoenanthus* (L.) Spreng CrE. Values expressed as mean ± SEM, (*n= 6*) animals/group.

As Figure 22 represents, both the control group and the group treated with 2000 mg/kg of the crude extract of *Cymbopogon schoenanthus* (L.) Spreng exhibited a gradual increase in body weight over the 14 days. However, the female mice treated with the crude extract showed a higher body weight at each time point (W0, W7, and W14) compared to the control group. The weight gain, particularly in the treated group, and in accordance with the OECD Guideline 423, suggests that the extract at a dose of 2000 mg/kg did not exert any toxic effects, on the contrary, it may indicate a good tolerance or even a potential nutritive of the crude extract at the administered dose.

5.3. Relative organ weights

Following the sacrifice of the animals on the 14th day of the study, the kidneys and liver were collected for macroscopic evaluation. No morphological abnormalities were visible concerning the shape and size of the organs. The relative weight of the organs is represented in Table 6.

Table 6. Relative organ weight of mice treated with *Cymbopogon schoenanthus* (L.) Spreng CrE and control group.

Group/organ	Liver	Kidneys
Control	65.48±2.32	11.19±0.33
2000 mg/kg	59.82±2.17 ns	11.44±0.48 ns

Values expressed as mean ± SD, n= 5 animals /group. ns: no significant differences ($p < 0.05$).

The results represented in Table 6, show no significant difference of organ relative weights between the control group and the treated mice with oral administration of the crude extract of *Cymbopogon schoenanthus* (L.) Spreng.

5.4. Biochemical analysis

On the 14th day of the study, several biochemical parameters were evaluated in the treated mice in order to assess the non-toxicity of the crude extract of *Cymbopogon schoenanthus* (L.) Spreng. The results are represented in Figure 23.

The kidneys play a crucial role in eliminating waste products and toxins from the body; therefore, renal function tests such as urea, creatinine, and uric acid are indispensable analyses for ensuring the health of the kidneys and detecting their dysfunction **(John & Pasha, 2024)**. The results for creatinine and uric acid showed no significant difference between the treated group and the control group ($p < 0.05$) (Figure 23). However, urea levels were lower compared to the control group.

Blood glucose monitoring plays a crucial role in protecting health and reducing the risk of diabetes **(Bolla & Priefer, 2020)**. The glycemia level of the treated group did not differ significantly from that of the control group ($p < 0.05$) (Figure 23), suggesting that CrE did not interact with glucose metabolism.

Liver function tests are among the most commonly performed assessments involving a panel of biomarkers **(Lui, 2018)**. Oxaloacetate transaminase (AST), glutamate-pyruvate transaminase (ALT), and alkaline phosphatase (ALP), as well as albumin, were tested. All of the precedent biomarkers demonstrated no significant variation in treated females compared to the control group ($p < 0.05$) (Figure 23). The results indicate that the CrE has no significant impact on liver function.

The lipid profile was assessed to evaluate the crude extract's effect on lipid metabolism; triglycerides showed a low level in the treated female mice compared to the control group, whereas cholesterol demonstrated a lower level (Figure 23), suggesting that the CrE of the plant has a hypocholesterolemic effect ($p < 0.05$).

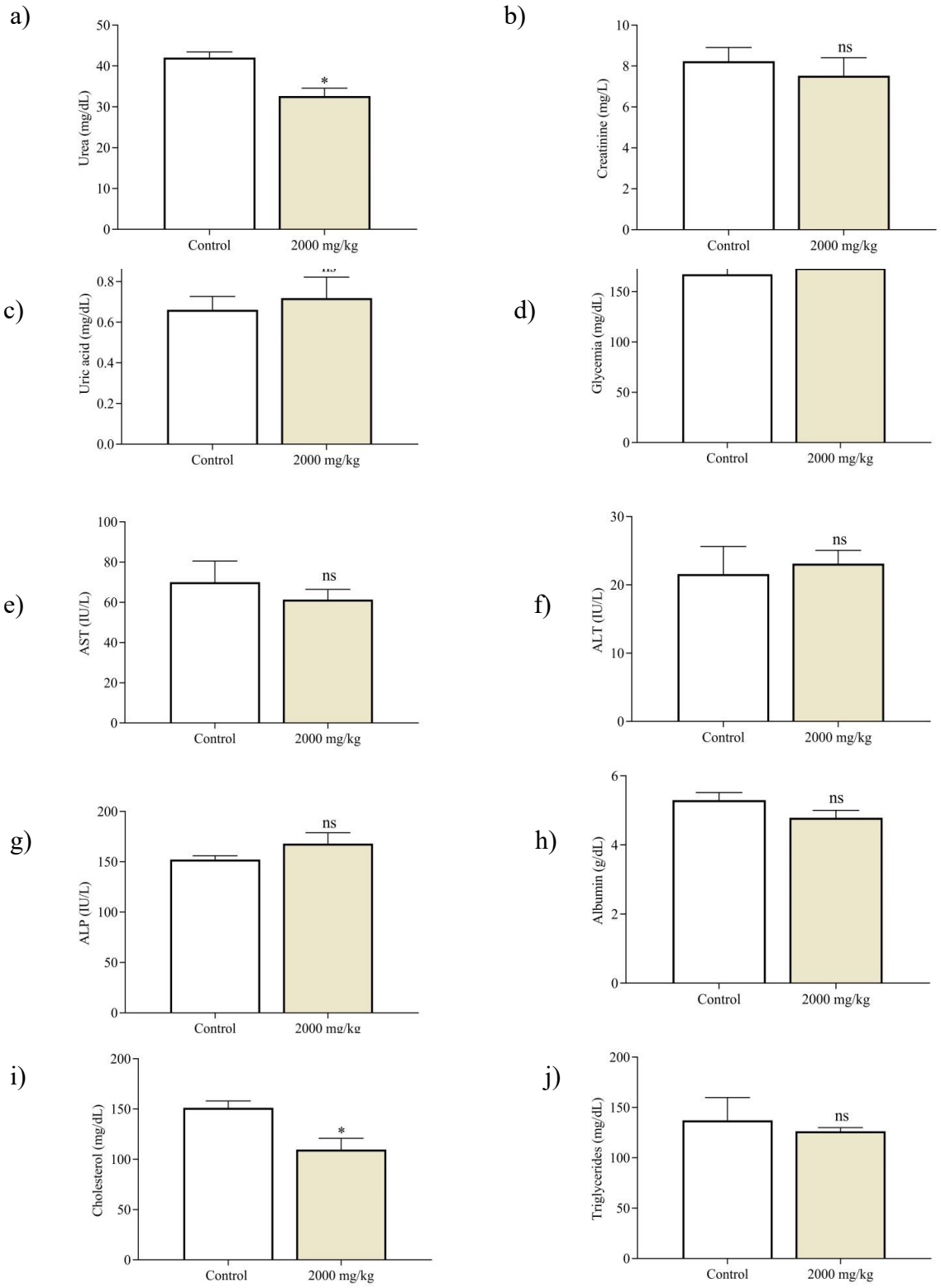

Figure 23. Biochemical parameters of control and treated mice groups assessed after the acute toxicity test. Values are given as mean ± SEM, (*n=6*). ns: no significant, *: $p < 0.05$. ALT: alanine aminotransferase, AST: aspartate aminotransferase, ALP: alkaline phosphatase, a) urea, b) creatinine, c) uric acid, d) glycemia, e) AST, f) ALT, g) ALP, h) albumin, i) cholesterol, j) triglycerides.

5.5. Histopathology

Histological sections of the kidneys and livers of control and treated mice are shown in Figure 24. The observation of histological sections of the livers of control mice (Figure 24A) and those treated with CrE at a dose of 2000 mg/kg (Figure 24B) revealed the preservation of hepatic cellular architecture. The kidneys of the control mice exhibit a normal renal appearance (Figure 24C) with no renal modifications, characterized by normal glomeruli and tubules, similar to those observed in mice treated with CrE at a dose of 2000 mg/kg (Figure 24D).

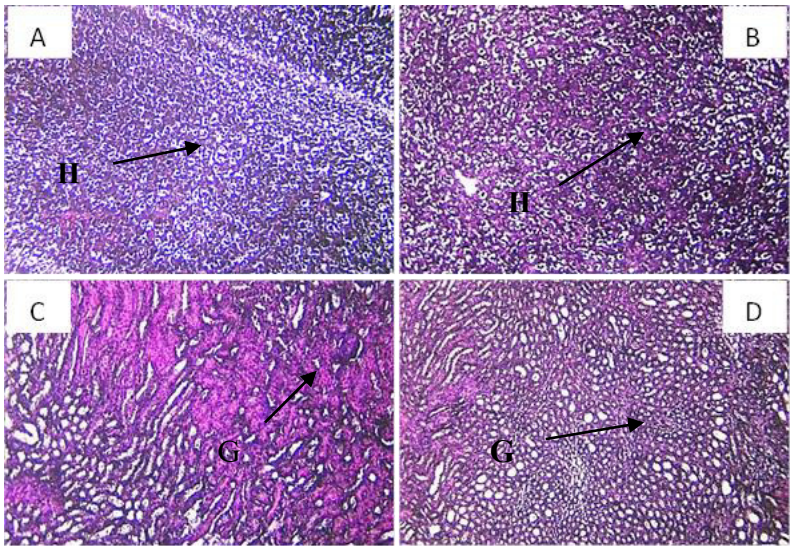

Figure 24. Histological sections of the liver parenchyma (magnification x10) of the control group (A) and treated group with crude extract 2000 mg/kg (B) and kidney parenchyma of the control group (C) and treated group with crude extract 2000 mg/kg (D). H: Hepatocytes, G: Glomerulis.

6. Analgesic activity of crude extract

Analgesics are drugs that are known for their pain-relieving properties by specifically targeting the site of pain without interfering with nerve impulse conduction. Naturally derived compounds from plants are widely utilized for managing mild pain due to their practical analgesic effects **(Banadka *et al*., 2022)**.

The analgesic effect of *Cymbopogon schoenanthus* (L.) Spreng crude extract was studied using the acetic acid-induced writhing test. A 0.6% acetic acid solution was injected intraperitoneally, 5 min later the number of contortions was counted for each mouse over a 15-minute period. The results are expressed in Figure 25.

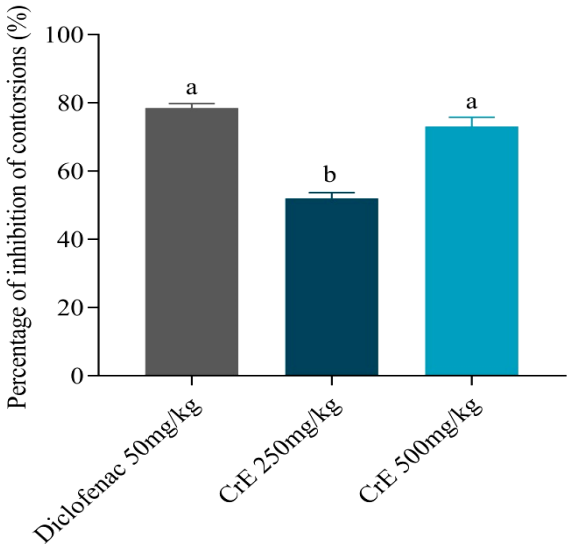

Figure 25. Analgesic effect of crude extract of *C. schoenanthus* (L.) Spreng. On acetic acid induced writhing test. Values were expressed as means ± SEM (*n=5*).

The administration of the crude extract at doses of 250 and 500 mg/kg significantly and dose-dependent inhibited the abdominal writhing induced by the injection of acetic acid, with percentages of 52.04 ± 1.70 and 73.13 ± 2.07%, respectively.

The most significant analgesic activity was observed at a dose of 500 mg/kg (73.13 ± 2.07%), which is comparable to that of sodium diclofenac (50 mg/mL), whose inhibition percentage is 78.51 ± 1.12% (ns; $p > 0.05$).

Irfan *et al.* (2015) obtained a value of 49.0% at a dose of (400mg/kg), using the crude extract of the species *Cymbopogon citratus.*

The induction of contortions by acetic acid administration is an experimental protocol recommended for the biological evaluation of analgesic activities **(Muhammad *et al.*, 2012)**. Whereas, the pain caused by the administration of acetic acid is due to the release of chemical mediators such as serotonin, histamine, and bradykinin **(Tijjani *et al.*, 2012; Bhowmick *et al.*, 2014)**.

Previous studies on the analgesic effects of plant extracts have reported that certain bio-compounds, such as flavonoids, are able to inhibit the release of numerous chemical mediators involved in pain **(Kouakou-Siransy *et al.*, 2010; Shilpi & Uddin, 2020; Gandhi *et al.*, 2023)**. This finding contributes to the possibility that our Plant's analgesic effect is based on the flavonoids present in the crude extract.

Conclusion and Perspectives

Medicinal plants have been used in traditional medicine for centuries and remain vital sources of pharmaceutical compounds. As part of our investigation into these therapeutic resources, we conducted an ethnobotanical study in the Ghardaïa region to examine the prevalence and applications of medicinal and aromatic plants in local herbal medicine practices. Our work primarily focused on investigating bioactive compounds through a phytochemical analysis of this plant species. This included toxicity assessment and evaluation of its antioxidant, antibacterial, and analgesic properties.

The extraction of polyphenols from the aerial parts of the *Cymbopogon schoenanthus* (L.) Spreng. plant begins with a hydroalcoholic mixture followed by fractionation using solvents of increasing polarity in order to separate the phenolic compounds into various phases. The maceration extraction yield was 7.26% for the crude extract (CrE), which was subsequently fractionated into four distinct extracts with varying yields: hexane extract (0.9%), ethyl acetate extract (0.2%), chloroform extract (0.1%), and aqueous extract (4.3%).

Spectrophotometric analysis revealed that the ethyl acetate extract (EAE) contained the highest concentrations of both total phenols (322.43±8.267 µg GAE/mg extract) and total flavonoids (45.53±21.88 µg QE/mg extract).

Due to the diversity of antioxidants and the complexity of oxidation processes, the antioxidant capacity of *Cymbopogon schoenanthus* (L.) Spreng. extracts were evaluated using multiple *in vitro* techniques, enabling a more comprehensive understanding of their antioxidant potential. The obtained results demonstrated that all extracts demonstrated effectiveness, with EAE showing the strongest antioxidant activity across multiple assays: it had the highest anti-radical potency in the DPPH test (IC_{50}=16.82±0.05 µg/mL), the best ABTS radical-scavenging ability (IC_{50}=92.01±1.95 µg/mL), and the most notable reducing power in the FRAP assay ($A_{0.5}$=65.66±1.88 µg/mL). However, in the TAC test, both HE and EAE displayed remarkable performance, with TAC values of 862.09± 29.93 µg/mg AAE and 513.26±13.81 µg/mg AAE, respectively. These findings highlight the promising antioxidant profile of *Cymbopogon schoenanthus* (L.) Spreng, and support its potential as a valuable natural source of antioxidant agents for use in pharmaceutical or nutraceutical applications.

The study of the antibacterial activity of extracts of *Cymbopogon schoenanthus* (L.) Spreng. was tested by the diffusion method on agar, the CrE and HE extracts showed only a moderate activity against *S. aureus* and *E. coli*. these results remain important as they suggest a selective antibacterial potential, particularly against Gram-positive and Gram-negative strains

of clinical relevance. This activity, even if limited, supports the idea that the plant may serve as a natural source of antimicrobial agents.

To evaluate the safety of the extract, we conducted an acute oral toxicity study *in vivo* at a dose of 2000 mg/kg for the CrE. Following oral administration, no mortality or toxic signs were observed. The LD_{50} was higher than 2000 mg/kg for CrE. The extracts can be considered non-toxic and thus suitable for pharmacological studies. Biochemical and histological parameters were also analyzed.

The histological examination of the livers and kidneys of the treated mice revealed no abnormalities with the renal and hepatic tissue architectures remained intact, with no signs of toxicity.

The *in vivo* analgesic assessment demonstrated that the CrE exerted significant analgesic effects, with inhibition rates of 52.04 ± 1.70% (250 mg/kg b.w.) and 73.13 ± 2.07% (500 mg/kg b.w.), indicating potent analgesic activity.

The present research expands the documented knowledge of *Cymbopogon schoenanthus* (L.) Spreng. and suggests several productive directions for future studies.

However, additional investigations are required to fully evaluate the therapeutic efficacy of the studied extracts:

- Characterization of active compounds in *Cymbopogon schoenanthus* (L.) Spreng. extracts using specific methods (HPLC and LC-MS) to determine structure-activity relationships.
- Assessment of other pharmacological properties such as anti-inflammatory and antidiabetic, antipyretic, and wound healing activities.
- Assessment of antioxidant effects in an *in vivo* biological model.

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Appendices

Appendice 1

University of Ghardaia

Faculty of Natural and Life Sciences and Earth Sciences

Department of Biology

Investigator : …….
Date : …….....
N° : …….....

Ethnobotanical Survey Form

Questionnaire:

Mark a cross in the box you deem appropriate.

Please answer precisely and honestly. Thank you for your cooperation.

Informant Profile :

- Name and surname : …….
- Sex : ☐ Male ☐ Female
- Age : ☐ < 20 ☐ [20-30] ☐ [31-40] ☐ [41-50] ☐ [51-60] ☐ > 60
- Education level : ☐ Illiterate ☐ Primar ☐ Secondary ☐ University
- Family situation : ☐ Single ☐ Married ☐ Widowed ☐ Divorced
- Study commune……...
- Profession type : …….
- Use of medicinal plants : ☐ Ancestral ☐ Training ☐ Both

Plant:

Local name / Vernacular name: ..... Scientific name: ….....

- Nature of the plant: ☐ Wild ☐ Cultivated ☐ Introduced ☐ Other
- Best season for harvesting: ☐ summer ☐ winter ☐ Spring ☐ Autumn ☐ All year
- Best time of day for harvesting: ☐ Morning ☐ Afternoon ☐ Evening
- Used in the state: ☐ Fresh ☐ Dry ☐ Both
- Part used: ☐ Root ☐ Stem ☐ Leaf ☐ Bark ☐ Rhizome ☐ flower ☐ Fruit ☐ Resin ☐ Seeds ☐ whole plant

Other : ……

- Drying and storage method : …… ……...

- Preparation method: ☐ Infusion ☐ Decoction ☐ Maceration ☐ Powder ☐ Poultice ☐ Fumigation
  Other: ……
- Dosage: ☐ Pinch ☐ Handful ☐ Spoonful ☐ Precise dose
- Mode of administration: ☐ Oral ☐ Inhalation ☐ Massage ☐ Rectal Enema
  Other: …….
- Dosage/frequency per day :

For children : ☐ 1x/day ☐ 2x/day ☐ 3x/day Other : ……
For adults : ☐ 1x/day ☐ 2x/day ☐ 3x/day Other : ……
For pregnant women: ☐ 1x/day ☐ 2x/day ☐ 3x/day Other : ……

- Duration of use: ☐ One day ☐ 1 week ☐ 1 month ☐ Until healing
- Mode of use of the plant: ☐ Alone ☐ Associated Possible association: ……

- Interaction with other plants: ☐Yes ☐ None Other: ……
- Culinary use: ☐ spices ☐culinary herbs Other: …….
- Types of diseases treated :

☐Dermatological condition
☐ Respiratory condition
☐ Cardiovascular condition
☐ Genitourinary condition
☐ Neurological condition
☐ Ocular condition
☐Hormonal condition
☐Hepatic condition
☐Digestive condition
☐Rheumatic diseases
☐HBP
☐ Diabetes

Other: ……

- Therapeutic effects : …….
- Results : ☐ Cured ☐ Improved ☐ Ineffective
- Side effects : ☐ Yes ☐No
- Toxicity : ☐ Yes ☐No

Other information :

Appendice 2

Toxicity study

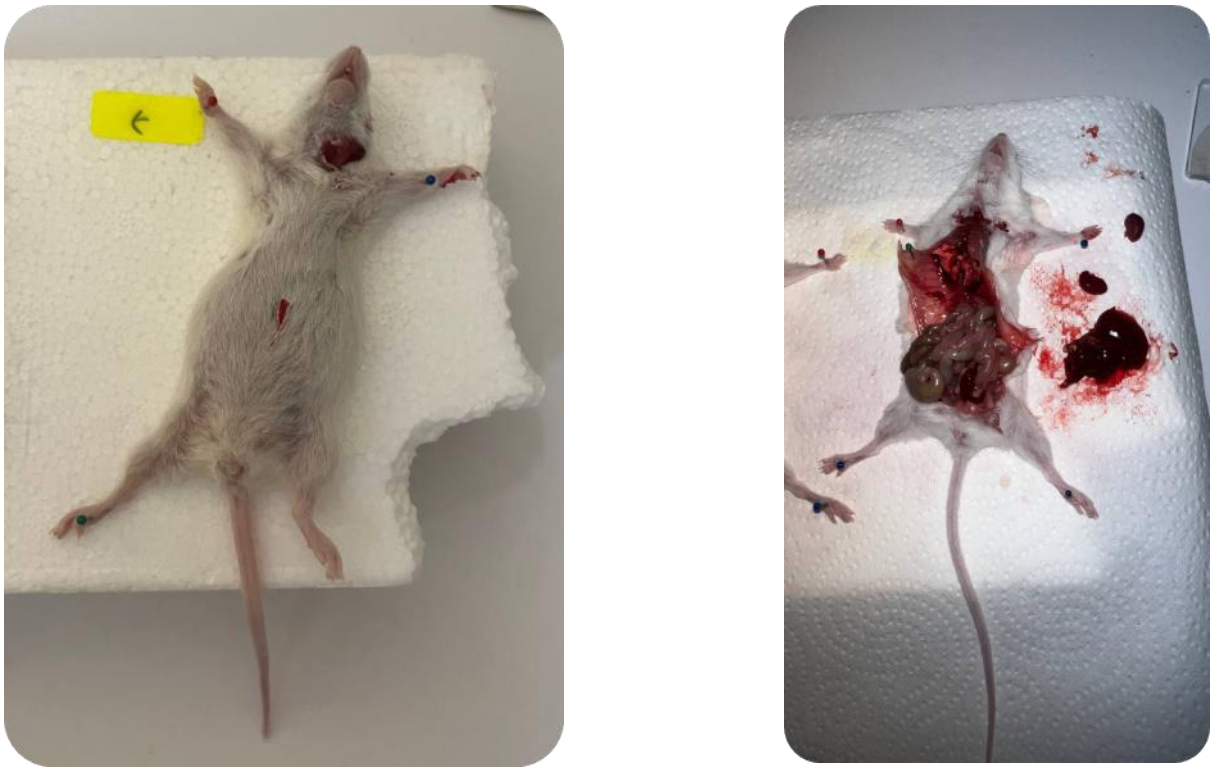

Figure 1. Internal organ inspection post-dissection.

Appendice 2

Analgesic activity

Figure 2. Oral administration of CrE and the intraperitoneal injection of acetic acid in mice for writhing test observation.

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CE

ACIDE URIQUE

Méthode colorimétrique URICASE

Réactif pour le dosage quantitatif de l'acide urique dans le plasma humain et les urines.

USAGE IN VITRO

IVD

REF	**15013**	**3 x 125 ml** (375 T)	**R1:** 3 x 125 ml	**R2:** 3 lyophilisats	**R3:** 1 x 6 ml
REF	**15020**	**4 x 30 ml** (120 T)	**R1:** 4 x 30 ml	**R2:**4 lyophilisats	**R3:** 1 x 4 ml
REF	**15037**	**2 x 30 ml** (60 T)	**R1:** 2 x 30 ml	**R2:**2 lyophilisats	**R3:** 1 x 4 ml
REF	**15044**	**5 x 120 ml** (600 T)	**R1:** 5 x 120 ml	**R2:** 5 lyophilisats	**R3:** 2 x 6 ml

SIGNIFICATION CLINIQUE

L'acide urique est un déchet produit par l'organisme. Il s'agit du produit final du métabolisme des acides nucléiques et des purines. L'hyperuricémie peut être causée par une production excessive d'acide urique ou par une diminution de son élimination par les reins. Le médecin prescrit un dosage sanguin et/ou un dosage urinaire de l'acide urique pour détecter la goutte, une insuffisance rénale ou en cas de grossesse. Ainsi, des taux élevés d'acide urique dans le sang peut être la conséquence d'une alimentation riche en purine.
Des prédispositions héréditaires sont retrouvées chez certains patients mais elles sont souvent associées à la suralimentation, l'abus d'alcool, le diabète et l'hypertriglycéridémie. En revanche, une hypourécémie, (moins courante que l'hyperurécémie) peut être liée à une pathologie rénale ou hépatique ou à un régime pauvre en purines.

PRINCIPE

L'acide urique est dosé selon les réactions suivantes :

$$\text{Acide urique} + 2H_2O + O_2 \xrightarrow{\text{Uricase}} \text{Allantoïne} + CO_2 + H_2O_2$$

$$2H_2O_2 + \text{Amino - 4-antipyrine} + \text{Dichloro 2- 4phenolsulfonate} \xrightarrow{\text{Peroxydase}} \text{Quinone rose} + 4H_2O$$

COMPOSITION DES REACTIFS

Réactif 1 Solution tampon	Tampon phosphate ; pH 7.4 Dichloro 2-4 Phénolsulfonate	50 mmol/l 4 mmol/l
Réactif 2 Enzymes	Uricase Peroxydase Amino-4-Antipyrine	70 UI/l 660 UI/l 1 mmol/l
Réactif 3 Standard	Standard Acide urique	6 mg/dl 60 mg/l 357 µmol/l

PRECAUTIONS

Les réactifs Biomaghreb sont destinés à du personnel qualifié, pour un usage in vitro (ne pas pipeter avec la bouche).
- Consulter la FDS en vigueur disponible sur demande ou sur www.biomaghreb.com;
- Vérifier l'intégrité des réactifs avant leur utilisation ; et
- Elimination des déchets : respecter la législation en vigueur.

Par mesure de sécurité, traiter tout spécimen ou réactif d'origine biologique comme potentiellement infectieux. Respecter la législation en vigueur.

PREPARATION DES REACTIFS

Dissoudre le lyophilisat R2 avec le contenu d'un flacon Tampon R1. Agiter doucement jusqu'à dissolution complète avant d'utiliser le réactif (environ 5 minutes).

PREPARATION DES ECHANTILLONS

Sérum, plasma héparié non hémolysé.
Urine diluée au 1/10 dans l'eau distillée.
Si l'échantillon d'urines est trouble, chauffer à 60°C pendant 10 minutes afin de dissoudre l'acide urique.

CONSERVATION ET STABILITE

- Avant ouverture : Jusqu'à la date de péremption indiquée sur l'étiquette du coffret à 2-8°C;
- Après ouverture : (Solution de travail) :
  7 jours à 20 -25°C
  3 semaines à 2-8°C

MATERIEL COMPLEMENTAIRES

- Equipement de base du laboratoire d'analyses médicales ;
- Spectrophotomètre ou Analyseur de biochimie clinique.

LIMITES

Des taux élevés de bilirubine et/ou d'acide ascorbique peuvent interférer négativement avec le dosage d'acide urique.

CONTROLE DE QUALITE

Programme externe de contrôle de la qualité.
Il est recommandé de contrôler dans les cas suivants:
- Au moins un contrôle par série.
- Changement de flacon de réactif.
- Après opérations de maintenance sur l'analyseur.

Lorsqu'une valeur de contrôle se trouve en dehors des limites de confiance, répéter l'opération en utilisant le même contrôle.
Utiliser des sérums de contrôle normaux et pathologiques.

CALIBRATION

Etalon du coffret (Réactif 3) où tout calibrant raccordé sur une méthode ou un matériau de référence.
La fréquence de calibration dépend des performances de l'analyseur et des conditions de conservation du réactif.
Il est recommandé de calibrer à nouveau dans les cas suivants:
1. changement du lot de réactif ;
2. après opérations de maintenance sur l'analyseur ; et
3. les valeurs de contrôle sortent des limites de confiance.

LINEARITE

La méthode est linéaire jusqu'à 250 mg/l (25 mg/dl = 1487,5 µmol/l).
Si la concentration en acide urique est supérieure à 250 mg/l, recommencer le test sur un échantillon dilué au 1/2 avec une solution de NaCl à 9 g/l.
Multiplier le résultat par 2.

MODE OPERATOIRE

Longueur d'onde : 510 nm (490-550) ;
Température : 20 - 25°C ;
Cuve : 1 cm d'épaisseur ;
Ajuster le zéro du spectrophotomètre par le Blanc Réactif pour le standard et les échantillons.

	Blanc	**Standard**	**Echantillon**
Standard	- -	20 µl	- -
Echantillon	- -	- -	20 µl
Solution de travail	1 ml	1 ml	1 ml
Mélanger, lire les absorbances après une incubation de 5 minutes à 37°C ou de 10 minutes à 20 - 25°C. La coloration est stable 30 minutes.			

CALCUL

- Sérum ou plasma :

$$\frac{\text{DO échtantillon}}{\text{DO Standard}} \times n$$

n = Valeur du standard

n =6 mg/dl ;
n =60 mg/l ;
n =357 µmol/l.

VALEURS DE REFERENCE

Sérum ou plasma	Femmes	2.5 - 6.0 mg/dl 25 - 60 mg/l 148 - 357 µmol/l
	Hommes	3.4 - 7.0 mg/dl 34 - 70 mg/l 200 - 416 µmol/l
Urine		250 - 750 mg/24 h

REFERENCES

Barham et Trinder, Analyst 97, 142 (1972) ;
Fossati et Principe, Clin. Chem. 28, 227 (1980).


Fabricant


Date de péremption

Usage "In vitro"


Température de conservation

Référence Produit


Consulter la notice


Conserver à l'abri de la lumière

Suffisant pour < n > essais

Numéro de lot

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ALBUMINE

Méthode colorimétrique BCG

Réactif pour le dosage quantitatif de l'albumine dans le plasma humain

USAGE IN VITRO

IVD

REF	**16010**	**2 x 250 ml** (250 T)	**R1:** 2 x 250 ml	**R2:** 1 x 3 ml
REF	**16027**	**4 x 500 ml** (1000 T)	**R1:** 4 x 500 ml	**R2:** 2 x 5 ml
REF	**16034**	**2 x 100 ml** (100 T)	**R1:** 2 x 100 ml	**R2:** 1 x 3 ml

SIGNIFICATION CLINIQUE

L'albumine est la protéine plasmatique la plus abondante. Elle est fabriquée par les hépatocytes, mais peut aussi provenir de l'alimentation. L'albumine participe au maintien de la pression oncotique dans le sang, mais peut également intervenir dans le transport des électrolytes ou des petites molécules endogènes ou exogènes qui seules, seraient éliminées par les reins telles que les hormones, la bilirubine, les acides gras, les médicaments. Le dosage de l'albuminémie est prescrit pour dépister une maladie hépatique ou rénale, ou pour vérifier la concentration des protéines ou de certains électrolytes, comme le calcium dans le sang.

PRINCIPE

A pH = 4.2, le vert de bromocrésol (BCG) se combine à l'albumine pour former un complexe coloré dont l'absorbance est proportionnelle à la concentration en albumine dans l'échantillon.

COMPOSITION DES REACTIFS

Réactif 1 Réactif de coloration	Vert de bromocrésol (BCG) Tampon succinate Brij	0,14 g/l 75 mmol/l 7 ml/l
Réactif 2 Standard	Albumine Bovine	200 mg/dl 2 g/l 5.17 mmol/l

PRECAUTIONS

Les réactifs Biomaghreb sont destinés à du personnel qualifié, pour un usage in vitro (ne pas pipeter avec la bouche).

- Consulter la FDS en vigueur disponible sur demande ou sur www.biomaghreb.com;
- Vérifier l'intégrité des réactifs avant leur utilisation ; et
- Elimination des déchets : respecter la législation en vigueur.

Par mesure de sécurité, traiter tout spécimen ou réactif d'origine biologique comme potentiellement infectieux. Respecter la législation en vigueur.

PREPARATION DES REACTIFS

Les réactifs sont prêts à l'emploi. Ils doivent être ramenés à la température ambiante avant leur utilisation.

PREPARATION DES ECHANTILLONS

Sérum, plasma hépariné non hémolysé.

CONSERVATION ET STABILITE

Conserver les réactifs entre 2 - 8°C jusqu'à la date de péremption indiquée sur le coffret.

MATERIEL COMPLEMENTAIRES

- Equipement de base du laboratoire d'analyses médicales ;
- Spectrophotomètre ou Analyseur de biochimie clinique.

LIMITES

Le clofibrate et la phénylbutazone produisent une interférence négative avec cette méthode. L'hémolyse ou la turbidité du sérum peut affecter le résultat du dosage en raison du rapport élevé de dilution.

CONTROLE DE QUALITE

Programme externe de contrôle de la qualité.

Il est recommandé de contrôler dans les cas suivants:

- Au moins un contrôle par série;
- Changement de flacon de réactif;
- Après opérations de maintenance sur l'analyseur.

Lorsqu'une valeur de contrôle se trouve en dehors des limites de confiance, répéter l'opération en utilisant le même contrôle.

Utiliser des sérums de contrôle normaux et pathologiques.

CALIBRATION

Etalon du coffret (Réactif 2) ou tout calibrant raccordé sur une méthode ou un matériau de référence.

La fréquence de calibration dépend des performances de l'analyseur et des conditions de conservation du réactif.

Il est recommandé de calibrer à nouveau dans les cas suivants:

1. changement du lot de réactif ;
2. après opérations de maintenance sur l'analyseur ; et
3. les valeurs de contrôle sortent des limites de confiance.

LINEARITE

La méthode est linéaire jusqu'à 1000 µmol/l (69g/l).

MODE OPERATOIRE

Longueur d'onde : 628 nm;

Température : 20 - 25°C;

Cuve : 1 cm d'épaisseur;

Ajuster le zéro du spectrophotomètre par le Blanc Réactif.

	Blanc	**Standard**	**Echantillon**
Standard (R2)	- -	10 µl	- -
Echantillon	- -	- -	10 µl
Réactif (R1)	2 ml	2 ml	2 ml
Mélanger, lire les absorbances après une incubation de 5 minutes à 20 - 25°C. La coloration est stable 30 minutes.			

CALCUL

$$\frac{\text{DO échtantillon}}{\text{DO Standard}} \times n$$

n = Valeur du standard

n = 50 g/l ;

n = 724.5 µmol/l.

VALEURS DE REFERENCE

Sérum	550-780 µmol/l 38-54 g/l

REFERENCES

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Drupt, F. Pharm. Biol 9,777 (1974).

Fabricant	Date de péremption	Usage "In vitro"	Température de conservation	Référence Produit	Consulter la notice	Conserver à l'abri de la lumière	Suffisant pour < n > essais	Numéro de lot

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CE

CHOLESTEROL

Méthode enzymatique colorimétrique (CHOD- PAP)

Réactif pour le dosage quantitatif du Cholestérol Total dans le plasma humain

USAGE IN VITRO

IVD

REF	**21014**	**3 x 120 ml** (360 T)	**R1:** 3 x 120 ml	**R2:** 3 lyophilisats	**R3:** 1 x 5 ml
REF	**21021**	**2 x 200 ml** (400 T)	**R1:** 2 x 200 ml	**R2:**2 lyophilisats	**R3:** 1 x 5 ml
REF	**21038**	**4 x 30 ml** (120 T)	**R1:** 4 x 30 ml	**R2:**4 lyophilisats	**R3:** 1 x 4 ml
REF	**21045**	**2 x 30 ml** (60 T)	**R1:** 2 x 30 ml	**R2:**2 lyophilisats	**R3:** 1 x 4 ml
REF	**21052**	**5 x 120 ml** (600 T)	**R1:** 5 x 120 ml	**R2:**5 lyophilisats	**R3:** 2 x 5 ml

SIGNIFICATION CLINIQUE

Le cholestérol est une molécule indispensable au bon fonctionnement de l'organisme, qui provient de l'alimentation ou synthétisée au niveau du foie. C'est une molécule insoluble dans le sang, transportée par des protéines « les lipoprotéines » : les LDL, HDL et les VLDL. Le dosage de la cholestérolémie est effectué dans le but de déceler une hypercholestérolémie, qui pourrait entrainer l'apparition de plaques d'athérome (l'athérosclérose), et peut servir également pour le diagnostic de pathologies hépatiques et thyroïdiennes. Dans certains cas, le suivi de la cholestérolémie s'effectue avant d'initier une thérapie médicamenteuse.

PRINCIPE

Le taux de cholestérol est mesuré après hydrolyse enzymatique puis oxydation. L'indicateur quinoneimine est formé à partir du peroxyde d'hydrogène et du amino 4 antipyrine en présence de phénol et de peroxydase selon les réactions suivantes :

Cholestérol estérase

Esters de cholestérol + H_2O ⟶ Cholestérol + Acides gras

Cholestérol oxydase

Cholestérol + O_2 ⟶ Cholestène-4-one-3 + H_2O_2

Péroxydase

H_2O_2 +Phénol + Amino-4–antipyrine ⟶ Quinoneimine rose

La quantité de quinoneimine formée est proportionnelle à la concentration du cholestérol.

COMPOSITION DES REACTIFS

Réactif 1 Solution tampon	Pipes pH 6.9 Phénol	90 mmol/l 26 mmol/l
Réactif 2 Enzymes	Cholestérol oxydase Peroxydase Cholestérol estérase Amino-4-antipyrine	300 U/l 1250 U/l 300 U/l 0.4 mmol/l
Réactif 3 Standard	Standard Cholestérol	200 mg/dl 2 g/l 5.17 mmol/l

PRECAUTIONS

Les réactifs Biomaghreb sont destinés à du personnel qualifié, pour un usage in vitro (ne pas pipeter avec la bouche).

- Consulter la FDS en vigueur disponible sur demande ou sur www.biomaghreb.com;
- Vérifier l'intégrité des réactifs avant leur utilisation ; et
- Elimination des déchets : respecter la législation en vigueur.

Par mesure de sécurité, traiter tout spécimen ou réactif d'origine biologique comme potentiellement infectieux. Respecter la législation en vigueur.

PREPARATION DES REACTIFS

Solution de travail :
Dissoudre le lyophilisat R2 avec le contenu d'un flacon Tampon R1.

PREPARATION DES ECHANTILLONS

Sérum, plasma hépariné non hémolysé.

CONSERVATION ET STABILITE

- Avant ouverture : Jusqu'à la date de péremption indiquée sur l'étiquette du coffret à 2-8°C;
- Après ouverture : (Solution de travail) :
  1 mois à 20-25°C;
  4 mois à 2-8°C.

MATERIEL COMPLEMENTAIRES

- Equipement de base du laboratoire d'analyses médicales ;
- Spectrophotomètre ou Analyseur de biochimie clinique.

CONTROLE DE QUALITE

Programme externe de contrôle de la qualité.
Il est recommandé de contrôler dans les cas suivants:

- Au moins un contrôle par série;
- Changement de flacon de réactif;
- Après opérations de maintenance sur l'analyseur.

Lorsqu'une valeur de contrôle se trouve en dehors des limites de confiance, répéter l'opération en utilisant le même contrôle.
Utiliser des sérums de contrôle normaux et pathologiques.

CALIBRATION

Etalon du coffret (Réactif 3) ou tout calibrant raccordé sur une méthode ou un matériau de référence.
La fréquence de calibration dépend des performances de l'analyseur et des conditions de conservation du réactif.
Il est recommandé de calibrer à nouveau dans les cas suivants:

1. changement du lot de réactif ;
2. après opérations de maintenance sur l'analyseur ; et
3. les valeurs de contrôle sortent des limites de confiance.

LINEARITE

La méthode est linéaire jusqu'à 6 g/l (600 mg/dl - 15.4 mmol/l). Si la concentration en cholestérol est supérieure à 6 g/l, diluer l'échantillon au 1/2 avec une solution de NaCl à 9 g/l et refaire le test. Multiplier le résultat par 2.

MODE OPERATOIRE

Longueur d'onde : 505 nm (500-550) ;
Température : 37°C ;
Cuve : 1 cm d'épaisseur ;
Ajuster le zéro du spectrophotomètre par le Blanc Réactif.

	Blanc	Standard	Echantillon
Standard	- -	10 µl	- -
Echantillon	- -	- -	10 µl
Solution de travail	1 ml	1 ml	1 ml
Mélanger, lire les absorbances après une incubation de 5 minutes à 37°C ou 10 minutes à 20-25°C. La coloration est stable 30 minutes.			

CALCUL

$$\text{Cholestérol} = \frac{\text{DO échtantillon}}{\text{DO Standard}} \times n$$

n = Valeur du standard

n = 200 mg/dl;
n = 2 g/l;
n = 5, 17 mmol/l.

VALEURS DE REFERENCE

Sérum ou plasma	3,6 à 5,7 mmol/l 1,4 à 2,2 g/l 140 à 220 mg/dl

REFERENCES

Trinder P., Ann. Clin. Biochem. 6, 24 (1969) ;
Richmond, Clin. Chem. 19, 1350 (1973) ;
Fasce C.F., Clin. Chem. 18901 (1982).

Fabricant | Date de péremption | Usage "In vitro" | Température de conservation | Référence Produit | Consulter la notice | Conserver à l'abri de la lumière | Suffisant pour < n > essais | Numéro de lot

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CE

CREATININE

Méthode cinétique colorimétrique sans déprotéinisation

Réactif pour le dosage quantitatif de créatinine dans le plasma humain et les urines

USAGE IN VITRO

IVD

REF	**25012**	**2 x 160 ml** (320 T)	**R1:** 2 x 80 ml	**R2:** 2 x 80 ml	**R3:** 1 x 15 ml
REF	**25029**	**2 x 500 ml** (1000 T)	**R1:** 1 x 500 ml	**R2:** 1 x 500 ml	**R3:** 2 x 25 ml
REF	**25036**	**1 x 500 ml** (500 T)	**R1:** 1 x 250 ml	**R2:** 1 x 250 ml	**R3:** 1 x 25 ml
REF	**25043**	**1 x 160 ml** (160 T)	**R1:** 1 x 80 ml	**R2:** 1 x 80 ml	**R3:** 1 x 8 ml

SIGNIFICATION CLINIQUE

La créatinine est produite après la dégradation de la créatine (protéine musculaire) par les reins
Le taux de créatinine permet d'avoir des informations sur le fonctionnement des reins et sur la masse musculaire du patient. Un taux de créatinine élevé est souvent le signe d'une insuffisance rénale. La mesure de sa clairance est donc un indicateur du débit de filtration glomérulaire.
Un taux bas de créatinine peut être le signe d'une myopathie (atrophie musculaire sévère).

PRINCIPE

La créatinine forme en milieu alcalin un complexe coloré avec l'acide picrique.
La vitesse de formation de ce complexe est proportionnelle à la concentration de créatinine.

COMPOSITION DES REACTIFS

Réactif 1	Hydroxyde de sodium	1.6 mmol/l
Réactif 2	Acide picrique	17.5 mmol/l
Réactif 3 Standard	Standard Créatinine	2 mg/dl 20 mg/l 176.8 µmol/l

PRECAUTIONS

Les réactifs Biomaghreb sont destinés à du personnel qualifié, pour un usage in vitro (ne pas pipeter avec la bouche).

- Consulter la FDS en vigueur disponible sur demande ou sur www.biomaghreb.com;
- Vérifier l'intégrité des réactifs avant leur utilisation ; et
- Vérifier l'intégrité des réactifs avant leur utilisation ; et
- Elimination des déchets : respecter la législation en vigueur.

Par mesure de sécurité, traiter tout spécimen ou réactif d'origine biologique comme potentiellement infectieux. Respecter la législation en vigueur.

PREPARATION DES REACTIFS

Solution de travail :
Mélanger à parts égales R1 et R2.

PREPARATION DES ECHANTILLONS

Sérum, plasma recueillis sur héparine
Urine diluée au 1/20 dans l'eau distillée (tenir compte de la dilution pour le calcul).

CONSERVATION ET STABILITE

- Avant ouverture : Les réactifs sont prêts à l'emploi, stables jusqu'à la date de péremption indiquée sur l'étiquette du coffret à 20-25°C;
- Après ouverture : (Solution de travail) : 1 mois à 20 - 25°C.

MATERIEL COMPLEMENTAIRES

- Equipement de base du laboratoire d'analyses médicales ;
- Spectrophotomètre ou Analyseur de biochimie clinique.

CONTROLE DE QUALITE

Programme externe de contrôle de la qualité.
Il est recommandé de contrôler dans les cas suivants:

- Au moins un contrôle par série.
- Changement de flacon de réactif.
- Après opérations de maintenance sur l'analyseur.

Lorsqu'une valeur de contrôle se trouve en dehors des limites de confiance, répéter l'opération en utilisant le même contrôle.
Utiliser des sérums de contrôle normaux et pathologiques.

CALIBRATION

Etalon du coffret (Réactif 3) ou tout calibrant raccordé sur une méthode ou un matériau de référence.
La fréquence de calibration dépend des performances de l'analyseur et des conditions de conservation du réactif.
Il est recommandé de calibrer à nouveau dans les cas suivants:

1. changement du lot de réactif ;
2. après opérations de maintenance sur l'analyseur ; et
3. les valeurs de contrôle sortent des limites de confiance.

LINEARITE

La méthode est linéaire jusqu'à 150 mg/l (15 mg/dl - 1326 µmol/l). Si la concentration en créatinine est supérieure à 150 mg/l, diluer l'échantillon au 1/2 avec une solution de NaCl à 9 g/l et recommencer le test. Multiplier le résultat par 2.

MODE OPERATOIRE

Longueur d'onde: 492 nm (490 - 510)
Température: 25 - 30 ou 37 °C
Cuve: 1 cm d'épaisseur
Ajuster le zéro du spectrophotomètre par l'air ou l'eau distillée.

	Standard	**Echantillon**
Standard	100 µl	- -
Echantillon	- -	100 µl
Solution de travail	1 ml	1 ml

Mélanger et lire les absorbances DO1 après 30 secondes.
Lire ensuite DO2 exactement 1 minute après.

CALCUL

Calculer Δ DO = DO2 - DO1 pour le standard et les échantillons.

$$\text{Créatinine} = \frac{\Delta \text{ DO échtantillon}}{\Delta \text{ DO Standard}} \times n$$

n = Valeur du standard

n = 2 mg/dl ;
n = 20 mg/l ;
n = 176.8 µmol/l

VALEURS DE REFERENCE

Sérum ou plasma	0.7 - 1.4 mg/dl 7-14 mg/l 61.8 -132.6 µmol/l
Urine	15-25 mg/kg/24h

REFERENCES

Henry J.B., Clinical Diagnosis and management 17th édition, Sauders Publisher 1984.
Larsen K., Clin. Chim. Acta 66, 209 (1972).

Fabricant	Date de péremption	Usage "In vitro"	Température de conservation	Référence Produit	Consulter la notice	Conserver à l'abri de la lumière	Suffisant pour < n > essais	Numéro de lot
		IVD		REF			Σ	LOT

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CE

GLUCOSE

Méthode colorimétrique (GOD- PAP)

Réactif pour le dosage quantitatif du glucose dans le plasma et le liquide céphalorachidien (LCR) humains

USAGE IN VITRO

IVD

REF	**26019**	**2 x 500 ml** (1000 T)	**R1:** 2 x 500 ml	**R2:** 2 lyophilisats	**R3:** 2 x 6 ml
REF	**26026**	**1 x 500 ml** (500 T)	**R1:** 1 x 500 ml	**R2:**1 lyophilisat	**R3:** 1 x 6 ml
REF	**26033**	**5 x 200 ml** (1000 T)	**R1:** 5 x 200 ml	**R2:**5 lyophilisats	**R3:** 2 x 6 ml
REF	**26040**	**4 x 100 ml** (400 T)	**R1:** 4 x 100 ml	**R2:**4 lyophilisats	**R3:** 1 x 5 ml
REF	**26057**	**2 x 100 ml** (200 T)	**R1:** 2 x 100 ml	**R2:**2 lyophilisats	**R3:** 1 x 3 ml

SIGNIFICATION CLINIQUE

La glycémie désigne le taux de glucose dans le sang. Ce glucide est le principal sucre de l'organisme et constitue sa principale source d'énergie. Sa concentration est régulée par les hormones pancréatiques : l'insuline, qui favorise son absorption dans les cellules ; et le glucagon, qui a le rôle inverse. Ce contrôle hormonal permet de maintenir une glycémie normale. Mais dans certains cas, la glycémie peut être supérieure ou inférieure aux valeurs de référence (comprises entre 0,7 et 1,05 g/l), et être de ce fait à l'origine de divers troubles. Une hyperglycémie apparaît peut être le signe de diabète, d'une hyperthyroïdie ou suite à une intervention chirurgicale. Au contraire, une hypoglycémie peut être le signe d'une dénutrition, d'une consommation excessive d'alcool, d'une insuffisance surrénalienne ou hypophysaire ou même d'une hypothyroïdie.

PRINCIPE

Détermination enzymatique du glucose selon les réactions suivantes :

$$\text{Glucose} + O_2 + H_2O \xrightarrow{\textbf{Glucose oxydase}} \text{Acide gluconique} + H_2O_2$$

$$2H_2O_2 + \text{Phénol} + \text{4-Aminoantipyrine} \xrightarrow{\textbf{Péroxydase}} \text{Quinoneimine rose} + 4H_2O$$

COMPOSITION DES REACTIFS

Réactif 1 Solution tampon	Tampon Tris pH= 7 Phénol	100 mmol/l 0,3 mmol/l
Réactif 2 Enzymes	Glucose oxydase Peroxydase Amino-4-antipyrine	10000 U/l 1000 U/l 2,6 mmol/l
Réactif 3 Standard	Standard Glucose	100 mg/dl 1 g/l 5,56 mmol/l

PRECAUTIONS

Les réactifs Biomaghreb sont destinés à du personnel qualifié, pour un usage in vitro (ne pas pipeter avec la bouche).

- Consulter la FDS en vigueur disponible sur demande ou sur www.biomaghreb.com;
- Vérifier l'intégrité des réactifs avant leur utilisation ; et
- Elimination des déchets : respecter la législation en vigueur.

Par mesure de sécurité, traiter tout spécimen ou réactif d'origine biologique comme potentiellement infectieux. Respecter la législation en vigueur.

PREPARATION DES REACTIFS

Solution de travail :
Dissoudre le lyophilisat R2 avec le contenu d'un flacon Tampon R1.

PREPARATION DES ECHANTILLONS

Sérum (non hémolysé) ;
Plasma recueilli sur fluorure-héparine ou héparine-iodacétate (non hémolysé) ;
Liquide Céphalo-rachidien.

CONSERVATION ET STABILITE

- Avant ouverture : Jusqu'à la date de péremption indiquée sur l'étiquette du coffret à 2-8°C;
- Après ouverture : (Solution de travail) :
  2 mois à 20 -25°C;
  8 mois à 2-8°C.

Stocker à l'abri de la lumière dans un flacon plastique exempt de toute contamination.

MATERIEL COMPLEMENTAIRES

- Equipement de base du laboratoire d'analyses médicales ;
- Spectrophotomètre ou Analyseur de biochimie clinique.

CONTROLE DE QUALITE

Programme externe de contrôle de la qualité.
Il est recommandé de contrôler dans les cas suivants:

- Au moins un contrôle par série;
- Changement de flacon de réactif;
- Après opérations de maintenance sur l'analyseur.

Lorsqu'une valeur de contrôle se trouve en dehors des limites de confiance, répéter l'opération en utilisant le même contrôle.
Utiliser des sérums de contrôle normaux et pathologiques.

CALIBRATION

Etalon du coffret (Réactif 3) ou tout calibrant raccordé sur une méthode ou un matériau de référence.
La fréquence de calibration dépend des performances de l'analyseur et des conditions de conservation du réactif.
Il est recommandé de calibrer à nouveau dans les cas suivants:

1. changement du lot de réactif ;
2. après opérations de maintenance sur l'analyseur ; et
3. les valeurs de contrôle sortent des limites de confiance.

LINEARITE

La méthode est linéaire jusqu'à 5 g/l (500 mg/dl 27,8 mmol/l). Si la concentration en glucose est supérieure à 5 g/l, recommencer le dosage sur l'échantillon dilué au 1/2 avec une solution de NaCl à 9 g/l. Multiplier le résultat par 2.

MODE OPERATOIRE

Longueur d'onde: 505 nm (492 - 550) ;
Température: 37 °C ;
Cuve: 1 cm d'épaisseur ;
Ajuster le zéro du spectrophotomètre par le Blanc Réactif.

	Blanc	**Standard**	**Echantillon**
Standard	- -	10 µl	- -
Echantillon	- -	- -	10 µl
Solution de travail	1 ml	1 ml	1 ml
Mélanger, lire les absorbances après 10 minutes d'incubation à 37 °C ou 30 minutes à 20-25 °C. La coloration est stable 30 minutes.			

CALCUL

$$\text{Glucose} = \frac{\text{DO échantillon}}{\text{DO Standard}} \times n$$

n = Valeur du standard

n = 100 mg/dl;
n = 1 g/l;
n = 5, 56 mmol/l.

VALEURS DE REFERENCE

Sérum ou plasma	70 - 105 mg/dl 0,70 - 1,05 g/l 3,89 - 5,84 mmol/l
Liquide céphalo-rachidien	50 - 70 mg/dl 0,50 - 0,70 g/l 2,78 - 3,89 mmol/l

Remarque :
Les substances suivantes n'interfèrent pas : Hémoglobine (jusqu'à 4 g/l), Bilirubine (jusqu'à 200 mg/l), Créatinine (jusqu'à 100 mg/l), Galactose (jusqu'à 1 g/l) et EDTA (jusqu'à 2 g/l).

REFERENCES

Dingeon B., Ann. Biol. Clin. 33, 3 (1975);
Lott J.A. Clin. Chem. 21. 1754 (1975);
Trinder P.n Ann. Clin. Biochem 6,24 (1969).

Fabricant | Date de péremption | Usage "In vitro" | Température de conservation | Référence Produit | Consulter la notice | Conserver à l'abri de la lumière | Suffisant pour < n > essais | Numéro de lot

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CE

GOT - ASAT

Méthode cinétique IFCC sans phosphate de pyridoxal

Détermination quantitative de l'activité de l'aspartate amino-transferase (EC 2.3.2.2) dans le sérum et le plasma humains

USAGE IN VITRO

IVD

REF	**10018**	**20 x 3 ml (60 T)**	**R1:** 1 x 65 ml	**R2:** 20 Lyophilisats
REF	**10025**	**10 x 10 ml (100 T)**	**R1:** 1 x110 ml	**R2:** 10 Lyophilisats
REF	**10032**	**10 x 3 ml (30 T)**	**R1:** 1 x 35 ml	**R2:** 10 Lyophilisats
REF	**10049**	**2 x 110 ml (220 T)**	**R1:** 2 x110ml	**R2:** 2 Lyophilisats

SIGNIFICATION CLINIQUE

L'ASAT (l'aspartate amino-transferase) autrefois appelée Glutamate Oxaloacétique Transaminase (GOT), est une enzyme localisée majoritairement dans les cellules cardiaques, hépatiques, et en moindre proportion, dans les cellules musculaires. Lorsque ces cellules sont altérées, elles libèrent l'enzyme dans le sang. Le dosage de l'activité ASAT est donc effectué dans le cadre d'un bilan hépatique, chez des patients atteints d'hépatite virale, de nécrose hépatique ou de cirrhose ; ou de nécrose cardiaque (à la suite d'un infarctus du myocarde). Son résultat est généralement interprété avec ceux de la phosphatase alcaline (PAL), et de l'Alanine Amino-transférase (ALAT). Dans certains cas, l'activité ASAT augmente lors de dystrophie musculaire ou de pancréatite aigüe.

PRINCIPE

La réaction est initiée par addition de l'échantillon au réactif selon le schéma réactionnel suivant :

$$2\ \text{oxoglutarate} + \text{L-Aspartate} \xrightarrow{\textbf{GOT}} \text{Glutamate} + \text{oxaloacetate}$$

$$\text{Oxaloacetate} + \text{NADH} + \text{H}^+ \xrightarrow{\textbf{MDH}} \text{Malate} + \text{NAD}^+$$

Le taux de diminution de la concentration en NADH est directement proportionnel à l'activité aspartate amino-transférase dans l'échantillon.

MDH: Malate Déshydrogénase

COMPOSITION DES REACTIFS

Réactif 1 Solution tampon	Tampon Tris pH 7.8 à 30°C L- aspartate	80 mmol/l 200 mmol/l
Réactif 2 Substrat	NADH LDH MDH Oxoglutarate	0,18 mmo/l 800 UI/l 600 UI/l 12 mmol/l

PRECAUTIONS

Les réactifs Biomaghreb sont destinés à du personnel qualifié, pour un usage in vitro (ne pas pipeter avec la bouche).

- Consulter la FDS en vigueur disponible sur demande ou sur www.biomaghreb.com
- Vérifier l'intégrité des réactifs avant leur utilisation.
- Elimination des déchets : respecter la législation en vigueur.

Par mesure de sécurité, traiter tout échantillon ou réactif d'origine biologique comme potentiellement infectieux. Respecter la législation en vigueur.

PREPARATION DES REACTIFS

Reprendre le substrat par 3 ml REF (10018) et REF (10032) ou 10 ml REF (10025) de Tampon R1.
Pour REF (10049) reconstituer chaque R2 par un flacon R1.

PREPARATION DES ECHANTILLONS

Sérum ou plasma hépariné sans hémolyse.

CONSERVATION ET STABILITE

Stockés à l'abri de la lumière, dans le flacon d'origine bien bouché à 2-8°C, les réactifs sont stables, s'ils sont utilisés et conservés dans les conditions préconisées :

- Avant ouverture : Jusqu'à la date de péremption indiquée sur l'étiquette du coffret à +4°C ;
- Après ouverture : (Solution de travail) :
  24 heures à 20 -25°C;
  7 jours à 2-8°C.

MATERIEL COMPLEMENTAIRES

- Equipement de base du laboratoire d'analyses médicales ;
- Spectrophotomètre ou Analyseur de biochimie clinique.

LIMITES

L'hémolyse peut interférer.

CONTROLE DE QUALITE

Programme externe de contrôle de la qualité.
Il est recommandé de contrôler dans les cas suivants:

- Au moins un contrôle par série.
- Changement de flacon de réactif.
- Après opérations de maintenance sur l'analyseur.

Lorsqu'une valeur de contrôle se trouve en dehors des limites de confiance, répéter l'opération en utilisant le même contrôle.
Utiliser des sérums de contrôle normaux et pathologiques.

LINEARITE

Si la ΔDO/min à 340 nm est supérieure à 0,15, répéter le test en diluant l'échantillon au 1/10 avec une solution de NaCl à 9 g/l.
Multiplier le résultat par 10.

MODE OPERATOIRE

Longueur d'onde : 340 nm ;
Température : 25 – 30 ou 37°C ;
Cuve : 1 cm d'épaisseur ;
Ajuster le zéro du spectrophotomètre sur l'air ou l'eau distillée.

Solution de travail	1 ml	3 ml
Préincuber à la température choisie (25, 30 ou 37°C)		
Echantillon	100 µl	300 µl
Mélanger et incuber 1 minute. Mesurer la diminution de la densité optique par minute pendant 1 à 3 minutes.		

CALCUL

Δ DO / min x 1750 = UI/l.

VALEURS DE REFERENCE

	25°C	**30°C**	**37°C**
Femmes	Jusqu'à 16 UI/l	Jusqu'à 22 UI/l	Jusqu'à 31UI/l
Hommes	Jusqu'à 19UI/l	Jusqu'à 26 UI/l	Jusqu'à 38UI/l

REFERENCES

Bergmeyer H; Bower and Cols. Clin. Chim Acta 70, (1976) ;
Bergmeyer H et Wahiegeld Clin. Chem 24, 58 (1978) ;
IFCC, Méthod for L-Aspartate aminotransferase, J Clin Chem. Clou Biachem (1986) 24. P497-510.

Fabricant | Date de péremption | Usage "In vitro" | Température de conservation | Référence Produit | Consulter la notice | Conserver à l'abri de la lumière | Suffisant pour < n > essais | Numéro de lot

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CE

GPT - ALAT

Méthode cinétique IFCC sans phosphate de pyridoxal

Détermination quantitative de l'activité de l'alanine amino transférase (EC 2.6.1.2) dans le sérum humain

USAGE IN VITRO

IVD

REF	**11015**	**20 x 3 ml (** 60 T)	**R1:** 1 x 65 ml	**R2:** 20 Lyophilisats
REF	**11022**	**10 x 10 ml (**100 T)	**R1:** 1 x110 ml	**R2:** 10 Lyophilisats
REF	**11039**	**10 x 3 ml (** 30 T)	**R1:** 1 x 35 ml	**R2:** 10 Lyophilisats
REF	**11046**	**2 x 110 ml (**220 T)	**R1:** 2 x110ml	**R2:** 2 Lyophilisats

SIGNIFICATION CLINIQUE

L'ALAT (l'alanine amino transférase) autrefois appelée Glutamique pyruvique Transaminase (GPT) est une enzyme présente essentiellement dans les cellules du foie, et en plus faible proportion dans les cellules rénales, cardiaques, et musculaires. La mesure de l'activité ALAT permet la détection des atteintes hépatiques. Lorsque le foie est atteint, l'ALAT est libérée dans la circulation sanguine chez les patients souffrant de cirrhose, hépatite, cancer et ictère par congestion biliaire). De façon générale, les valeurs de l'activité ALAT sont comparées aux activités d'autres enzymes comme les phosphatases alcalines (PAL), l'aspartate amino transférase (ASAT) et la bilirubine pour définir de façon précise l'origine des atteintes hépatiques.

PRINCIPE

La détermination cinétique de l'activité ALAT est basée sur la méthode développée par Wrobleski et la due, et optimisée par Henry et Bergmeyer.
La réaction est initiée par addition de l'échantillon au réactif selon le schéma réactionnel suivant :

$$\text{2 oxoglutarate + L-Aspartate} \xrightarrow{\textbf{GPT}} \text{Glutamate + oxaloacetate}$$

$$\text{Oxaloacetate + NADH + H}^{+} \xrightarrow{\textbf{LDH}} \text{Malate + NAD}^{+}$$

Le taux de diminution de la concentration en NADH est directement proportionnel à l'activité alanine amino transférase dans l'échantillon.

LDH : Lactate Déshydrogénase

COMPOSITION DES REACTIFS

Réactif 1 Solution tampon	Tampon Tris pH 7.5 à 30°C Alanine	100 mmol/l 500 mmol/l
Réactif 2 Substrat	NADH LDH Oxoglutarate	0.18 mmo/l 1200 U/l 15 mmol/l

PRECAUTIONS

Les réactifs Biomaghreb sont destinés à du personnel qualifié, pour un usage in vitro (ne pas pipeter avec la bouche).

- Consulter la FDS en vigueur disponible sur demande ou sur www.biomaghreb.com.
- Vérifier l'intégrité des réactifs avant leur utilisation.
- Elimination des déchets : respecter la législation en vigueur.

Par mesure de sécurité, traiter tout échantillon ou réactif d'origine biologique comme potentiellement infectieux. Respecter la législation en vigueur.

PREPARATION DES REACTIFS

Solution de travail :
Reprendre le substrat par 3 ml REF (11015) et REF (11039) ou 10 ml REF (11022) de Tampon R1.
Pour REF (11046) reconstituer chaque R2 par un flacon R1.

PREPARATION DES ECHANTILLONS

Sérum ou plasma hépariné sans hémolyse.

CONSERVATION ET STABILITE

Stockés à l'abri de la lumière, dans le flacon d'origine bien bouché à 2-8°C, les réactifs sont stables, s'ils sont utilisés et conservés dans les conditions préconisées :

- Avant ouverture : Jusqu'à la date de péremption indiquée sur l'étiquette du coffret à +4°C ;
- Après ouverture : (Solution de travail) :
  24 heures à 20-25°C;
  7 jours à 2-8°C.

MATERIEL COMPLEMENTAIRES

- Equipement de base du laboratoire d'analyses médicales ;
- Spectrophotomètre ou Analyseur de biochimie clinique.

LIMITES

L'hémolyse peut interférer.

CONTROLE DE QUALITE

Programme externe de contrôle de la qualité.
Il est recommandé de contrôler dans les cas suivants:

- Au moins un contrôle par série.
- Changement de flacon de réactif.
- Après opérations de maintenance sur l'analyseur.

Lorsqu'une valeur de contrôle se trouve en dehors des limites de confiance, répéter l'opération en utilisant le même contrôle.
Utiliser des sérums de contrôle normaux et pathologiques.

LINEARITE

Si la ΔDO/min à 340 nm est supérieure à 0.15, répéter le test en diluant l'échantillon au 1/10 avec une solution de NaCl à 9 g/l.
Multiplier le résultat par 10.

MODE OPERATOIRE

Longueur d'onde : 340 nm ;
Température : 25 – 30 ou 37°C ;
Cuve : 1 cm d'épaisseur ;
Ajuster le zéro du spectrophotomètre sur l'air ou l'eau distillée.

Solution de travail	1 ml	3 ml
Préincuber à la température choisie (25, 30 ou 37°C)		
Echantillon	100 µl	300 µl
Mélanger et incuber 1 minute. Mesurer la diminution de la densité optique par minute pendant 1 à 3 minutes.		

CALCUL

À la longueur d'onde **340 nm,**
Δ DO / min x 1750 = UI/l.

VALEURS DE REFERENCE

	25°C	**30°C**	**37°C**
Femmes	Jusqu'à 16 UI/l	Jusqu'à 22 UI/l	Jusqu'à 31UI/l
Hommes	Jusqu'à 22 UI/l	Jusqu'à 29 UI/l	Jusqu'à 40UI/l

REFERENCES

Bergmeyer H. Schaibe and Walefeld. Clin. Chem. 24 58 - 73 (1978);
Bergmeyer and Horder Clin. Chem. Acta 105 147 F (1980) ;
Henry R, J, et al,, Am J clin Path (1960), 34, 381-398.

Fabricant | Date de péremption | Usage "In vitro" | Température de conservation | Référence Produit | Consulter la notice | Conserver à l'abri de la lumière | Suffisant pour < n > essais | Numéro de lot

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CE

PHOSPHATASE ALCALINE

Méthode DGKG

Détermination cinétique de l'activité phosphatase alcaline (EC 3.1.3.1)

USAGE IN VITRO

IVD

REF 13019	20 x 3 ml (60 T)	**R1:** 20 x 3 ml	**R2:** 1 x 7 ml
REF 13026	10 x 10 ml (100 T)	**R1:** 10 x 10 ml	**R2:** 1 x 11 ml
REF 13033	4 x 50 ml (200 T)	**R1:** 4 x 50 ml	**R2:** 2 x 11 ml
REF 13040	10 x 3 ml (30 T)	**R1:** 10 x 3 ml	**R2:** 1 x 3,5 ml

SIGNIFICATION CLINIQUE

Les phosphatases alcalines (PAL) sont des enzymes localisées dans la plupart des tissus de l'organisme, particulièrement dans les os, le foie, l'intestin, les reins, et le placenta. Environ 80% de l'activité PAL circulante provient des iso formes d'origine hépatique et osseuse. Le dosage de l'activité des PAL est souvent prescrit en cas de suspicion de maladie du foie ou des os. Une augmentation de l'activité PAL est constatée lors d'une cholestase ou des obstructions biliaires, ou bien dans le cadre de pathologies osseuses telles que le rachitisme, la maladie de Paget, l'ostéomalacie, et les métastases osseuses.

PRINCIPE

Il s'agit de la détermination cinétique de l'activité phosphatase alcaline (PAL) selon la méthode recommandée par la société allemande de chimie clinique (DGKG).
En milieu alcalin, les phosphatases alcalines catalysent l'hydrolyse du Nitrophénylphosphate en Nitrophénol et en phosphate.
La cinétique de formation du nitrophénol est proportionnelle à l'activité PAL dans l'échantillon.

COMPOSITION DES REACTIFS

Réactif 1 Solution tampon	Tampon diéthanolamine pH 9,8 Chlorure de magnésium	1 mmol/l 0,5 mmol/l
Réactif 2 Substrat	Nitrophénylphosphate	10 mmol/l

PRECAUTIONS

Les réactifs Biomaghreb sont destinés à du personnel qualifié, pour un usage in vitro (ne pas pipeter avec la bouche).

- Consulter la FDS en vigueur disponible sur demande ou sur www.biomaghreb.com
- Vérifier l'intégrité des réactifs avant leur utilisation.
- Elimination des déchets : respecter la législation en vigueur.

Par mesure de sécurité, traiter tout échantillon ou réactif d'origine biologique comme potentiellement infectieux. Respecter la législation en vigueur.

PREPARATION DES REACTIFS

Solution de travail :

Reprendre le flacon R1 par la quantité de R2 nécessaire, indiquée ci-dessous :

REF 13019 et REF 13040 : R1..... 3 ml
R2.....0,3 ml
REF 13026 : R1.....10 ml
R2.....1 ml
REF 13033 : R1.....50 ml
R2.....5 ml

PREPARATION DES ECHANTILLONS

Sérum ou plasma hépariné sans hémolyse.

CONSERVATION ET STABILITE

- Avant ouverture : Jusqu'à la date de péremption indiquée sur l'étiquette du coffret à 2-8°C;
- Après ouverture : (Solution de travail) :
  5 jours à 15 -25°C;
  15 jours à 2-8°C.

MATERIEL COMPLEMENTAIRES

- Equipement de base du laboratoire d'analyses médicales ;
- Spectrophotomètre ou Analyseur de biochimie clinique.

CONTROLE DE QUALITE

Programme externe de contrôle de la qualité.

Il est recommandé de contrôler dans les cas suivants:

- Au moins un contrôle par série ;
- Changement de flacon de réactif ;
- Après opérations de maintenance sur l'analyseur.

Lorsqu'une valeur de contrôle se trouve en dehors des limites de confiance, répéter l'opération en utilisant le même contrôle.

Utiliser des sérums de contrôle normaux et pathologiques.

LINEARITE

Si la variation moyenne de D.O/min > 0,250 refaire le test en diluant l'échantillon au 1/5 dans une solution de NaCl à 9g/l et multiplier le résultat par 5.

MODE OPERATOIRE

Longueur d'onde : 405 nm ;

Température : 25- 30 ou- 37°C ;

Cuve : 1 cm d'épaisseur ;

Ajuster le zéro du spectrophotomètre sur l'air ou l'eau distillée.

Solution de travail	1 ml
Equilibrer à 25 - 30 ou 37°C	
Echantillon	20 µl
Mélanger et introduire dans une cuve thermostatée. Attendre 1 minute puis mesurer l'augmentation moyenne de la densité optique par minute pendant 1 à 3 minutes.	

Remarque : La mesure de l'activité enzymatique est meilleure dans les quatre heures qui suivent le prélèvement.

CALCUL

A 405 nm .....PAL (UI/L) = ΔD.O/min x 2750;

A 410 nm .....PAL (UI/L) = ΔD.O/min x 2910.

VALEURS DE REFERENCE

	25°C	30°C	37°C
Enfants	400 UI/l	500 UI/l	650 UI/l
Adultes	40 -190 UI/l	50 - 230 UI/l	70 - 300 UI/l

REFERENCES

Haussamen T.U. et al. Clin. Chim. Acta. 35, 271-273 (1977).

Fabricant | Date de péremption | Usage "In vitro" | Température de conservation | Référence Produit | Consulter la notice | Conserver à l'abri de la lumière | Suffisant pour < n > essais | Numéro de lot

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CE

TRIGLYCERIDES

Méthode colorimétrique enzymatique GPO-PAP

Réactif pour le dosage quantitatif des Triglycérides dans le plasma ou le sérum humains

USAGE IN VITRO

IVD

REF	**29010**	**2 x 120 ml** (240 T)	**R1:** 2 x 120 ml	**R2:** 2 lyophilisats	**R3:**1 x 4 ml
REF	**29027**	**4 x 30 ml** (120 T)	**R1:** 4 x 30 ml	**R2:**4 lyophilisats	**R3:**1 x 3 ml
REF	**29034**	**2 x 30 ml** (60 T)	**R1:** 2 x 30 ml	**R2:**2 lyophilisats	**R3:**1 x 2 ml
REF	**29041**	**5 x 120 ml** (600 T)	**R1:** 5 x 120 ml	**R2:**5 lyophilisats	**R3:** 2 x 5 ml
REF	**29058**	**2 x 200 ml** (400 T)	**R1:** 2 x 200 ml	**R2:** 2 lyophilisats	**R3:**1 x 7 ml

SIGNIFICATION CLINIQUE

Les triglycérides sont des lipides qui servent de réserve énergétique synthétisées par le foie ou provenant de l'alimentation. Un taux de triglycérides élevé dans le sang constitue un facteur de risque cardiovasculaire majeur. La détermination du taux de triglycérides totaux est effectuée dans le cadre d'un bilan lipidique, en même temps que le dosage du cholestérol (total, HDL et LDL), pour détecter une dyslipidémie. Une hypertriglycéridémie est souvent favorisée par une prédisposition génétique, un syndrome métabolique (obésité, hypertension artérielle, diabète …), un régime alimentaire hypercalorique, par la prise de certains médicaments (les corticoïdes, les antipsychotiques, les bétabloquants …).

PRINCIPE

Les triglycérides sont déterminés selon les réactions suivantes :

Lipoprotéine lipase
Triglycérides ⟶ Glycérol + Acides gras
Glycérokinase, Mg ++
Gylcérol + ATP ⟶ Glycérol -3-P + ADP
Glycérol-3- Phosphate oxydase
Glycérol-3-Phosphate + O_2 ⟶ H_2O_2+ Dihydroxyacétone-P
H_2O_2+Amino-4-Antipyrine + chloro-4-phénol
Peroxydase
Quinoneimine rose + H_2O

COMPOSITION DES REACTIFS

Réactif 1 Solution tampon	Tampon pipes pH 7,2 Chloro-4-phénol	50 mmol/l 2 mmol/l
Réactif 2 Enzymes	Lipoproteine lipase Glycérokinase Glycérol 3-P-Oxydase Peroxydase Amino-4-antipyrine ATP	150000 U/l 800 U/l 4000 U/l 440 U/l 0,7 mmol/l 0,3 mmol/l
Réactif 3 Standard	Standard glycérol (en trioléine)	200 mg/dl 2 g/l 2,28 mmol/l

PRECAUTIONS

Les réactifs Biomaghreb sont destinés à du personnel qualifié, pour un usage in vitro (ne pas pipeter avec la bouche).

- Consulter la FDS en vigueur disponible sur demande ou sur www.biomaghreb.com;
- Vérifier l'intégrité des réactifs avant leur utilisation ; et
- Vérifier l'intégrité des réactifs avant leur utilisation ; et
- Elimination des déchets : respecter la législation en vigueur.

Par mesure de sécurité, traiter tout spécimen ou réactif d'origine biologique comme potentiellement infectieux. Respecter la législation en vigueur.

PREPARATION DES REACTIFS

Solution de travail :
Dissoudre le lyophilisat R2 avec un flacon de tampon R1.

PREPARATION DES ECHANTILLONS

Sérum, plasma recueilli sur héparine.

CONSERVATION ET STABILITE

- Avant ouverture : Les réactifs sont prêts à l'emploi, stables jusqu'à la date de péremption indiquée sur l'étiquette du coffret à 20-25°C;
- Après ouverture : (Solution de travail) :
  semaine à 20 - 25°C ;
  28 jours à 2-8°C.

MATERIEL COMPLEMENTAIRES

- Equipement de base du laboratoire d'analyses médicales ;
- Spectrophotomètre ou Analyseur de biochimie clinique.

CONTROLE DE QUALITE

Programme externe de contrôle de la qualité.
Il est recommandé de contrôler dans les cas suivants:

- Au moins un contrôle par série.
- Changement de flacon de réactif.
- Après opérations de maintenance sur l'analyseur.

Lorsqu'une valeur de contrôle se trouve en dehors des limites de confiance, répéter l'opération en utilisant le même contrôle.
Utiliser des sérums de contrôle normaux et pathologiques.

CALIBRATION

Etalon du coffret (Réactif 3) ou tout calibrant raccordé sur une méthode ou un matériau de référence.
La fréquence de calibration dépend des performances de l'analyseur et des conditions de conservation du réactif.
Il est recommandé de calibrer à nouveau dans les cas suivants:

1. changement du lot de réactif ;
2. après opérations de maintenance sur l'analyseur ; et
3. les valeurs de contrôle sortent des limites de confiance.

LINEARITE

La méthode est linéaire jusqu'à 10 g/l (1000 mg/dl -11,4 mmol/l). Si la concentration est plus importante, diluer l'échantillon au 1/10 avec une solution de NaCl à 9 g/l et refaire le dosage. Multiplier le résultat par 10.

MODE OPERATOIRE

Longueur d'onde: 505 nm (490nm-550nm) ;
Température : 37°C ;
Cuve:1 cm d'épaisseur ;
Ajuster le zéro du spectrophotomètre par le blanc réactif.

	Blanc	Standard	Echantillon
Standard	- -	10 µl	- -
Echantillon	- -	- -	10 µl
Solution de travail	1 ml	1 ml	1 ml
Mélanger et lire les absorbances après une incubation de 5 minutes à 37°C ou de 10 minutes à 20-25°C. La stabilité de la coloration est de 30 minutes.			

Remarques : Les triglycérides sont stables dans le sérum 3 jours à 2 - 8°C.

CALCUL

$$\text{Triglycérides} = \frac{\Delta \text{ DO échtantillon}}{\Delta \text{ DO Standard}} \times n$$

n = Valeur du standard

n = 2 g/l;
n = 200 mg/dl;
n = 2, 28 mmol/l

VALEURS DE REFERENCE

Sérum ou plasma	Femmes	40 - 140 mg/dl 0,4 – 1,40 g/l 0,46 – 1,60 mmol/l
	Hommes	60 - 165 mg/dl 0,60 – 1,65 g/l 0,68 – 1,88 mmol/l

REFERENCES

Fossati P., Prencipe I., Clin. Chem. 28, 2077 (1982);
Young D., Pestaner L., Clin. Chem., 21,5 (1975).

Fabricant | Date de péremption | Usage "In vitro" | Température de conservation | Référence Produit | Consulter la notice | Conserver à l'abri de la lumière | Suffisant pour < n > essais | Numéro de lot

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CE

UREE COLOR

Méthode colorimétrique Berthelot modifiée

Réactif pour le dosage quantitatif de l'urée
dans le plasma humain et les urines

USAGE IN VITRO

IVD

REF	**30016**	**1 x 500 ml** (500 T)	**R1:** 1 x 500 ml	**R2:** 1 lyophilisat	**R3:** 1 x 5 ml	**R4:**1 x 50 ml
REF	**30023**	**2 x 500 ml** (1000 T)	**R1:** 2 x 500 ml	**R2:** 2 lyophilisats	**R3:** 2 x 5 ml	**R4:**2 x 50 ml
REF	**30030**	**2 x 100 ml** (200 T)	**R1:** 2 x 100 ml	**R2:**2 lyophilisats	**R3:** 1 x 4 ml	**R4:**2 x 10 ml
REF	**30047**	**1 x 100 ml** (100 T)	**R1:** 1x 100 ml	**R2:** 1 lyophilisats	**R3:** 1 x 4 ml	**R4:**1 x 10 ml

SIGNIFICATION CLINIQUE

L'urée est une molécule résultant du processus de catabolisme des protéines, éliminée par les reins sous forme de déchets azotés.
La détermination du taux de l'urée permet donc d'évaluer la fonction rénale, plus particulièrement chez les personnes diabétiques et les patients ayant subi un infarctus du myocarde. Dans le cas de dysfonctionnement rénal, il y a une augmentation de l'urémie. De plus, certaines pathologies du foie peuvent également altérer le taux d'urée dans le sang.
Le dosage de l'urée seule n'est pas très informatif, étant donné que l'urée produite chaque jour varie en fonction de l'alimentation, de l'âge et de l'état d'hydratation. De ce fait, les dosages de la créatinine et d'acide urique sont généralement effectués en même temps. En outre, la détermination de la clairance de l'urée permet d'évaluer la vitesse de filtration des reins, et l'efficacité de la dialyse.

PRINCIPE

Les ions ammonium, en présence de salicylate et d'hypochlorite de sodium réagissent en formant un composé de couleur verte (Dicarboxyl-indophenol) dont l'intensité est proportionnelle à la concentration en urée selon la réaction suivante :

$$\text{Urée} + H_2O \xrightarrow{\text{Uréase}} 2NH_3 + CO_2$$

COMPOSITION DES REACTIFS

Réactif 1	Solution tampon	
Réactif 2	EDTA Salicylate de sodium Nitroprussiate de sodium Uréase Phosphate pH 6.7	2 mmol/l 60 mmol/l 32 mmol/l 30000 U/l 60 mmol/l
Réactif 3 Standard	Standard Urée	0.5 g/l 50 mg/dl 8.325 mmol/l
Réactif 4 (10 x concentré)	Hypochlorite de sodium Hydroxyde de sodium	40 mmol/l 150 mmol/l

PRECAUTIONS

Les réactifs Biomaghreb sont destinés à du personnel qualifié, pour un usage in vitro (ne pas pipeter avec la bouche).

- Consulter la FDS en vigueur disponible sur demande ou sur www.biomaghreb.com.
- Vérifier l'intégrité des réactifs avant leur utilisation ; et
- Elimination des déchets : respecter la législation en vigueur

Par mesure de sécurité, traiter tout spécimen ou réactif d'origine biologique comme potentiellement infectieux. Respecter la législation en vigueur.

PREPARATION DES REACTIFS

Solution de travail :
Dissoudre le flacon R2 dans le tampon R1.
Le réactif 4 est à compléter avec :
- 90 ml d'eau distillée : REF 30030 et REF 30047 ;
- 450 ml d'eau distillée: REF 30016 et REF 30023.

PREPARATION DES ECHANTILLONS

Sérum, plasma recueilli sur héparine. Urine diluée au 1/50 avec de l'eau distillée.

CONSERVATION ET STABILITE

- Avant ouverture : Jusqu'à la date de péremption indiquée sur l'étiquette du coffret à 2-8°C;
- Après ouverture : (Solution de travail) :
  14 jours à 20 -25°C ;
  6 mois à 2-8°C.

MATERIEL COMPLEMENTAIRES

- Equipement de base du laboratoire d'analyses médicales ;
- Spectrophotomètre ou Analyseur de biochimie clinique.

CONTROLE DE QUALITE

Programme externe de contrôle de la qualité.
Il est recommandé de contrôler dans les cas suivants:

- Au moins un contrôle par série.
- Changement de flacon de réactif.
- Après opérations de maintenance sur l'analyseur.

Lorsqu'une valeur de contrôle se trouve en dehors des limites de confiance, répéter l'opération en utilisant le même contrôle.
Utiliser des sérums de contrôle normaux et pathologiques.

CALIBRATION

Etalon du coffret (Réactif 3) ou tout calibrant raccordé sur une méthode ou un matériau de référence.
La fréquence de calibration dépend des performances de l'analyseur et des conditions de conservation du réactif.
Il est recommandé de calibrer à nouveau dans les cas suivants:

1. changement du lot de réactif ;
2. après opérations de maintenance sur l'analyseur ; et
3. les valeurs de contrôle sortent des limites de confiance.

LINEARITE

La méthode est linéaire jusqu'à 4 g/l (66,6 mmol/l).
Dans les urines, la méthode est linéaire jusqu'à 100 g/l.

MODE OPERATOIRE

Longueur d'onde: 590 nm (578 Hg) ;
Température : 25-30-37°C ;
Cuve: 1 cm d'épaisseur ;
Ajuster le zéro du spectrophotomètre par le blanc réactif.

	Blanc	**Standard**	**Echantillon**
Standard	- -	10 µl	- -
Echantillon	- -	- -	10 µl
Solution de travail	1 ml	1 ml	1 ml

Mélanger, incuber 5 min. à 37° C ou 10 min. à 20-25°C.
Ajouter ensuite :

Réactif R4	1 ml	1 ml	1 ml

Mélanger et lire les absorbances après une incubation de 5 min, à 37°C ou 10 min à 20° - 25°C.

La stabilité de la coloration est de 2 heures à l'abri de la lumière.

CALCUL

$$\text{Urée} = \frac{\text{DO échtantillon}}{\text{DO Standard}} \times n$$

n = Valeur du standard

n = 50 mg/dl;
n = 0, 5 g/l;
n = 8,325 mmol/l.

VALEURS DE REFERENCE

Sérum ou plasma	15 - 40 mg/dl 0,15 – 0,40 g/l 2,49 – 6,66 mmol/l
Urine	20 - 35 g/24 h

REFERENCES

Balleter, W.G., Bushaman, C.S., Tidwell, P.W., Anal. Chim. 33,59 Berthelot, M.P.E., Report Chim. Appl. 284 (1859) ;
Mac Key, E.M., Rackeyll, J. Clin. Invest, J. Clin.Invest. 4, 295 (1927).

Fabricant	Date de péremption	Usage "In vitro"	Température de conservation	Référence Produit	Consulter la notice	Conserver à l'abri de la lumière	Suffisant pour < n > essais	Numéro de lot