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THEME

**Phytochemical screening and pharmaceutical effect of
*Portulaca oleracea.L***

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Abstract

Phytochemical screening and pharmaceutical effect of *Portulaca oleracea* L

Portulaca oleracea L., commonly known as purslane, is a medicinal plant rich in bioactive compounds including flavonoids, phenolic acids, and omega-3 fatty acids. This graduation project aimed to investigate the antioxidant and anti-inflammatory properties of a cream formulated from *P. oleracea* extract, and to evaluate its novel potential in treating cutaneous warts. Antioxidant activity was assessed using DPPH and FRAP assays, where the extract demonstrated concentration-dependent effects comparable to ascorbic acid. Anti-inflammatory effects were observed through inhibition of human serum albumin denaturation, slightly inferior to diclofenac but still significant. In a clinical evaluation involving 20 participants, the topical application of either fresh plant paste or cream showed gradual but visible improvements in wart symptoms, with faster results from the fresh paste. These findings highlight the plant's potential not only in oxidative and inflammatory conditions, but also as an innovative natural remedy for viral skin lesions.

Keywords : *Portulaca oleracea*, antioxidant, anti-inflammatory, wart treatment, natural extract, cream formulation.

Criblage phytochimique et effet pharmaceutique de *Portulaca oleracea* L

Portulaca oleracea L., communément appelée pourpier, est une plante médicinale riche en composés bioactifs tels que les flavonoïdes, les acides phénoliques et les acides gras oméga-3. Ce projet de fin d'études visait à évaluer les propriétés antioxydantes et anti-inflammatoires d'une crème formulée à partir d'un extrait de *P. oleracea*, ainsi que son potentiel innovant dans le traitement des verrues cutanées. L'activité antioxydante a été mesurée à l'aide des tests DPPH et FRAP, montrant une efficacité dose-dépendante comparable à celle de l'acide ascorbique. L'effet anti-inflammatoire a été démontré par l'inhibition de la dénaturation de l'albumine sérique humaine, avec une efficacité légèrement inférieure à celle du diclofénac. Lors d'une évaluation clinique sur 20 participants, l'application topique de pâte fraîche ou de crème a montré une amélioration progressive des verrues, plus marquée avec la pâte fraîche. Ces résultats suggèrent que cette plante pourrait être utilisée comme traitement naturel innovant contre les lésions virales de la peau.

Mots-clés : *Portulacaoleracea*, antioxydant, anti-inflammatoire, traitement des verrues, extrait naturel, formulation en crème.

الفحص الكيميائي النباتي والتأثير الصيدلاني لنبات الرجلّة

تُعد نبتة الرجلّة (*Portulaca oleracea L.*) من النباتات الطبية الغنية بالمركبات الفعالة بيولوجيًا مثل الفلافونويدات، الأحماض الفينولية، وأحماض أوميغا-3 الدهنية، وهدف هذا المشروع إلى دراسة الخصائص المضادة للأكسدة والمضادة للالتهاب لكريم مكون من مستخلص الرجلّة، وتقييم قدرته الجديدة في علاج التآليل الجلدية، وأظهرت نتائج اختباري DPPH وFRAP فعالية مضادة للأكسدة تعتمد على التركيز، وكانت قريبة من فعالية حمض الأسكوربيك، وكما أظهر المستخلص قدرة جيدة على تثبيط تغير طبيعة ألبومين المصل البشري بفعل الحرارة، ورغم أنها أقل قليلاً من فعالية الديكلوفيناك، وفي تقييم سريري شمل 20 شخصًا، أظهرت تطبيقات المعجون الطازج أو الكريم تحسنًا تدريجيًا في أعراض التآليل، وكان التحسن أسرع عند استخدام النبات الطازج، وتشير هذه النتائج إلى إمكانية استخدام الرجلّة كعلاج طبيعي مبتكر ليس فقط في الحالات الالتهابية والتأكسدية، بل أيضًا في علاج آفات الجلد الفيروسية.

الكلمات المفتاحية: الرجلّة، مضاد أكسدة، مضاد التهاب، علاج التآليل، مستخلص طبيعي، كريم علاجي.

List of abbreviations

List of abbreviations

List of abbreviations:

Abs	Absorbance, the measure of the amount of light absorbed by a sample
AQ	Aqueous, referring to water-based solutions
AsA	Ascorbic Acid, used as a standard reference antioxidant.
Conc	Concentration, the amount of a substance in a defined volume
Ctrl	Control, the untreated or baseline group in experiments.
DPPH	2,2-Diphenyl-1-picrylhydrazyl, a stable free radical compound commonly used to assess antioxidant activity through radical scavenging.
Ext	Extract, referring to the sample obtained from plant material.
FRAP	Ferric Reducing Antioxidant Power, a method that measures the antioxidant capacity by evaluating the ability to reduce ferric (Fe^{+3}) to ferrous (Fe^{+2}) ions.
HSA	Human Serum Albumin, a protein used in anti-inflammatory assays as an indicator of protein stabilization.
IC₅₀	Inhibitory Concentration 50, the concentration of a substance required to inhibit a biological process by 50%.
MeOH	Methanol, a solvent used in extract preparation.
mg	Milligram, a unit of mass
Min	Minute, a unit of time.
ml	Milliliter, a unit of volume.
nm	Nanometer, a unit of measurement for wavelength.
OD	Optical Density, often synonymous with absorbance in spectrophotometry
PO	Portulaca oleracea, the scientific name of purslane, the plant under investigation.
Rpm	Revolutions per minute, typically used to describe centrifugation speed.
Std	Standard, a known reference used for comparison.
T°	Temperature, usually expressed in degrees Celsius.
US	Ultrasonication, a technique using ultrasound energy for extraction or dispersion.
UV	Ultraviolet, referring to ultraviolet light used in spectrophotometric analysis.
%	Percent, a measure of proportion.

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Introduction

I. Introduction

Portulaca oleracea L., commonly known as purslane, is an important medicinal plant widely distributed across tropical and subtropical regions. This plant is known for its ability to withstand harsh environmental conditions, which makes it prevalent in various ecosystems. *P. oleracea* is rich in several bioactive compounds, including amino acids, vitamins, omega-3 fatty acids, minerals, and a variety of phenolic compounds and flavonoids, which are known for their health benefits.^[1]

Over the years, several scientific studies have explored the therapeutic potential of purslane. One of its most notable properties is its antioxidant activity, attributed to its rich content of phenolic compounds and flavonoids. These compounds help neutralize free radicals, protecting cells from oxidative damage. Furthermore, research suggests that these antioxidant properties may reduce the risk of chronic diseases, particularly cardiovascular disorders^[1]

In addition to its antioxidant effects, purslane has also been studied for its anti-inflammatory properties. Studies have shown that purslane extracts effectively reduce pro-inflammatory cytokines such as TNF- α and IL-6, which makes it beneficial in treating inflammatory conditions such as arthritis and respiratory disorders^[2]

Emerging evidence also suggests that purslane may have a positive effect on human albumin, reducing inflammation associated with albumin, thus potentially providing benefits in immune-related disorders^[3]. Moreover, purslane has been shown to regulate blood glucose levels, making it relevant for managing metabolic diseases such as diabetes^[4].

Another valuable property of purslane is its antimicrobial activity. Extracts of purslane have demonstrated effectiveness against several bacterial strains, including *Staphylococcus aureus* and *Bacillus subtilis*. These findings suggest that purslane could be used as a natural

antimicrobial agent. Additionally, its ability to enhance immune responses further supports its role in combating infections^[4]

This study aims to explore a less-studied aspect of *P. oleracea*'s therapeutic potential—its role in the treatment of warts. While the plant has been extensively researched for various medical applications, its use in wart treatment has been insufficiently explored. Preliminary results from this study indicate that purslane extracts may reduce the size of warts and expedite the healing process^[4].

Introduction

In conclusion, this introduction provides a comprehensive overview of the diverse therapeutic properties of *P. oleracea*, with a focus on its antioxidant, anti-inflammatory effects, its impact on human albumin, and its emerging role in treating warts, adding a new perspective to the field of alternative medicine.

Although numerous studies have investigated the medicinal properties of *Portulaca oleracea* L., some of its therapeutic applications remain underexplored—particularly its potential in treating cutaneous warts. Can purslane extracts serve as an effective natural remedy for warts, alongside their well-documented antioxidant, anti-inflammatory, and antimicrobial properties ?

Materials and Methods

Materials and Methods

I. Materials

This section describes the materials and procedures employed throughout the experimental work.

I.1. Description of *Portulaca oleracea*

Portulaca oleracea, commonly known as purslane, is a succulent annual herb featuring reddish creeping stems, fleshy green leaves, and small yellow flowers that open in the morning and close after a few hours. It belongs to the family Portulacaceae, order Caryophyllales, division Magnoliophyta, and class Magnoliopsida^[1].

Table (1): Taxonomic Classification of *Portulaca oleracea*

Taxonomic Rank	Classification
Kingdom	Plantae
Clade	Angiosperms
Clade	Eudicots
Order	Caryophyllales
Family	Portulacaceae
Genus	<i>Portulaca</i>
Species	<i>Portulaca oleracea</i> L.
Common Name	Purslane (English) بقلة / الرجيلة (Arabic)

This plant is rich in biologically active compounds such as flavonoids, alkaloids, omega-3 fatty acids (especially α -linolenic acid), phenolic compounds, and essential vitamins A, C, and E, which confer antioxidant, anti-inflammatory, and antimicrobial properties. It is considered one of the most abundant plant-based sources of omega-3 fatty acids, making it highly valuable for human nutrition^{[1][2]}.

Although its exact origin is debated, *P. oleracea* is believed to have originated in the Mediterranean basin and southwestern Asia. It has since spread globally and is now naturalized across Europe, North Africa, the Indian subcontinent, Southeast Asia, Australasia, and the Americas. Notably, archaeological findings at Crawford Lake in Ontario, Canada, indicate that pollen and seeds of purslane date between 1350–1539 AD, suggesting its presence in North America prior to the Columbian exchange^{[1][2][3]}.

Ecologically, purslane thrives in disturbed soils, roadside edges, gardens, and abandoned fields. Its succulent nature and water-conserving metabolism allow it to tolerate drought and salinity effectively^[12].

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Figure (1):*Portulaca oleracea* – morphological features of the plant.

In this study, the presence and distribution of *Portulaca oleracea* were specifically documented in El Oued Province in southeastern Algeria, where it prominently appears in arid to semi-arid environments, benefiting from its adaptability to harsh climatic conditions, sandy soils, and relatively saline waters^[16].



Figure (2): Map of the study area – El Oued Province, Algeria

I.2. Antibacterial Test Organisms

Four bacterial species were evaluated for antibacterial activity: *Staphylococcus aureus*, *Escherichia coli*, *Pseudomonas aeruginosa*, and *Bacillus* spp.

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Staphylococcus aureus is a Gram-positive, facultative anaerobic coccus arranged in grape-like clusters, commonly colonizing human skin and nasal mucosa. It causes diverse infections ranging from superficial skin abscesses to life-threatening conditions such as pneumonia, endocarditis, septicemia, and toxic shock syndrome. Clinical treatment is complicated by the rise of methicillin-resistant strains (MRSA), and the bacterium's ability to form biofilms further enhances its pathogenicity and resistance ^{[1][2]}.

Escherichia coli is a Gram-negative, facultatively anaerobic bacillus, typically found in the human gut flora. While many strains are commensal, pathogenic types can cause gastrointestinal disorders, urinary tract infections, and sepsis. Its lipopolysaccharide-rich outer membrane and varied virulence factors make it a standard model in antibacterial testing ^[3].

Pseudomonas aeruginosa is a Gram-negative, aerobic rod known for its opportunistic behavior, especially in immunocompromised patients. It is a significant cause of hospital-acquired infections including ventilator-associated pneumonia, burn wound infections, and urinary tract infections. Renowned for its metabolic versatility, low antibiotic susceptibility—largely due to efflux pumps and biofilm formation—and production of virulence factors like pyocyanin and rhamnolipids, *P. aeruginosa* is also a key ESKAPE pathogen ^{[4][5]}.

Bacillus species are Gram-positive, rod-shaped, spore-forming bacteria found worldwide in soil and environmental niches. Although many are non-pathogenic and valued in biotechnology (e.g., *B. subtilis*), some species like *B. cereus* can cause foodborne illness and opportunistic infections. Their robust spores and capacity to produce antimicrobial peptides make *Bacillus* spp. useful indicators in antimicrobial assays ^[6].

Table (2):Bacterial species with description and gram type

Name	Description	Gram
<i>Staphylococcus aureus</i>	Forms yellowish, smooth, shiny colonies. Causes skin infections, pneumonia, and sepsis.	Gram-positive
<i>Pseudomonas aeruginosa</i>	Produces green metallic colonies with a fruity smell. Infects wounds and the respiratory tract.	Gram-negative
<i>Escherichia coli</i>	Forms moist, grayish, round	Gram-negative

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	colonies. Some strains cause foodborne illnesses.	
<i>Bacillus spp</i>	Forms large, rough, dry colonies. Spore-forming and survives harsh conditions.	Gram-positive

I.3. Antifungal Test Organisms

The fungal genera tested for antifungal activity include *Candida spp.*, *Penicillium spp.*, and ***Aspergillus spp***.

Candida spp. are opportunistic yeasts that colonize mucosal surfaces (oral, intestinal, genitourinary) and can cause pathologies ranging from superficial candidiasis to disseminated systemic infections in immunocompromised individuals. Their virulence is linked to morphological transitions (yeast–hyphae), adhesins, biofilm production, and secretion of hydrolytic enzymes ^[1].

Penicillium spp. are ubiquitous environmental molds found in soil, decaying material, and indoor spaces. Although mostly benign, certain species (excluding *P. marneffei*) have been implicated in rare cases of invasive infections—such as pulmonary, cerebral, and cutaneous forms—in both immunocompromised and, occasionally, immunocompetent patients ^[2].

Aspergillus spp., particularly *A. fumigatus*, are filamentous fungi with airborne spores that pose serious infection risks, especially in patients with neutropenia or on immunosuppressants. They cause a spectrum of diseases—from allergic and chronic pulmonary conditions to invasive aspergillosis—burning host tissues via proteases and hyphal invasion ^[3].

Table (3) : Fungal Taxonomic Classification

Genus	Fungal Type	Morphology	Phylum	Class
<i>Candida spp</i>	Yeast	Unicellular, dimorphic	Ascomycota	Saccharomycetes
<i>Penicillium spp</i>	Mold	Filamentous (conidiophores)	Ascomycota	Eurotiomycetes
<i>Aspergillus spp</i>	Mold	Filamentous (hyphae, spores)	Ascomycota	Eurotiomycetes

Materials and Methods

I.4. Some Materials and Reagents Used in the Assays

During the experimental procedures, several laboratory instruments and reagents were utilized across the different assays. A UV-Visible spectrophotometer was used to measure absorbance values in antioxidant and anti-inflammatory tests. An incubator and a dry oven were employed to maintain appropriate temperatures during microbial culturing and protein denaturation steps. Analytical balances, micropipettes, glassware (test tubes, beakers, Petri dishes), and a vortex mixer were also involved in sample preparation and handling. Reagents such as DPPH, ferric chloride (FeCl_3), potassium ferricyanide, ascorbic acid, methanol, phosphate buffer, bovine serum albumin (BSA), as well as culture media like Mueller-Hinton agar and Sabouraud dextrose agar were used in the different assays.

II. Method

II.1. Determination of flavonoid content using the aluminum chloride colorimetric method

The materials used for the determination of flavonoid content include a plant extract or any sample containing flavonoids, methanol or ethanol as extraction solvents, aluminum chloride (AlCl_3), sodium acetate (NaOAc), distilled water, and a spectrophotometer for measuring absorbance. Aluminum chloride and sodium acetate are essential reagents for forming a measurable complex with flavonoids^[5].

To prepare the sample, the plant material is first extracted using methanol or ethanol. The sample is soaked in the solvent for 24 hours at room temperature with occasional shaking to enhance extraction. After soaking, the mixture is filtered to obtain a clear extract free from solid residues^[6].

For reagent preparation, a 10% aluminum chloride solution is prepared by dissolving AlCl_3 in methanol or ethanol. Additionally, a 5% sodium acetate solution is made using distilled water. These solutions are freshly prepared before the test^[7]

In the reaction step, 1 mL of the extract is transferred to a test tube. Then, 1 mL of the aluminum chloride solution and 1 mL of the sodium acetate solution are added. The mixture is diluted with distilled water to reach a total volume of 5 mL. The test tube is left to stand at room temperature for 30 minutes, allowing the flavonoid-aluminum complex to form, which produces a yellow coloration^[7].

The absorbance of the resulting solution is measured at 430 nm using a spectrophotometer. A blank solution containing only the solvents and reagents is used for calibration. The flavonoid

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content is quantified by comparing the absorbance of the sample with a standard calibration curve prepared using known concentrations of quercetin or another flavonoid standard. The results are usually expressed in milligrams of quercetin equivalent per gram of sample^[8].

II.2. Totalpolyphenol content report

Folin–Ciocalteu reagent, *gallic acid* (as a standard), *sodium carbonate* (Na_2CO_3), and distilled water were used in this experiment. All reagents were of analytical grade and obtained from reputable suppliers^[9].

A known amount (1 g) of the plant extract was dissolved in 10 mL of methanol. The solution was filtered using Whatman No. 1 filter paper to obtain a clear extract^[6].

The total polyphenol content was determined using the *Folin–Ciocalteu* colorimetric method. In brief, 0.5 mL of the plant extract was mixed with 2.5 mL of 10% *Folin–Ciocalteu* reagent. After 5 minutes, 2 mL of 7.5% sodium carbonate solution was added. The mixture was then incubated in the dark at room temperature for 30 minutes.^[10]

The absorbance of the mixture was measured at 760 nm using a UV-Vis spectrophotometer. A calibration curve was prepared using standard solutions of *gallic acid*.^[11]

The total polyphenol content was calculated from the calibration curve and expressed as milligrams of *gallic acid* equivalents per gram of dry sample (mg GAE/g DW).^[12]

II.3.DPPH radical scavenging assay

The antioxidant activity of *Portulaca oleracea* extract was evaluated using the DPPH (2,2-diphenyl-1-picrylhydrazyl) radical scavenging method,^[13] In this assay, 3 mg of the cream was dissolved in 3 ml of distilled water, followed by sonication at 30°C for 5 minutes to ensure proper mixing of the extract. The DPPH solution was prepared by dissolving 4 mg of DPPH in 100 ml of methanol, and it was stored in the dark to preserve its activity^[14]

Ascorbic acid was used as the reference antioxidant. A 2 mg concentration of *ascorbic acid* was dissolved in 2 ml of distilled water, and this solution was treated in the same manner as the extract solution^[14] Three dilution series were prepared, with each containing 6 test tubes with varying concentrations of the extract. Each test tube received 1 ml of the extract or *ascorbic acid* solution, mixed with 1 ml of DPPH solution. The mixture was incubated in the dark at room temperature for 30 minutes^[14]. After incubation, absorbance was measured at 517 nm using a UV-Visible spectrophotometer, and antioxidant activity was calculated based on the absorbance of the samples in comparison to the control and *ascorbic acid* reference^[14]

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II.4.FRAP (ferric reducing antioxidant power) assay

The FRAP assay was used to assess the ferric reducing antioxidant power of the *Portulaca oleracea* cream extract. The required reagents for the assay included *phosphate buffer* (0.2 M, pH 6.6), *trichloroacetic acid* (TCA), *potassium ferricyanide* [$K_3Fe(CN)_6$], and *ferric chloride* ($FeCl_3$). A 0.1% TCA solution was prepared by dissolving 50 mg of TCA in 0.5 ml of distilled water. *Potassium ferricyanide* and *ferric chloride* solutions were prepared by dissolving 5 mg of $K_3Fe(CN)_6$ in 0.5 ml of distilled water and 1 mg of $FeCl_3$ in 1 ml of distilled water, respectively^[15]

A stock solution of the cream extract was prepared by dissolving the sample in distilled water. Three different dilution series were prepared, each containing six test tubes with increasing concentrations^[15]. For the assay, each test tube was treated with the cream extract (or standard) mixed with phosphate buffer and *potassium ferricyanide*, followed by incubation at 50°C for 20 minutes. After incubation, 0.5 ml of TCA solution was added, and the mixture was centrifuged at 3000 rpm for 10 minutes. The supernatant was collected, and ferric chloride solution was added to initiate the color reaction. Absorbance was measured at 700 nm using a UV-Visible spectrophotometer, and higher absorbance values indicate greater ferric reducing antioxidant power^[15]

II.5.Anti-inflammatory activity via human serum albumin denaturation assay

The anti-inflammatory activity of the *Portulaca oleracea* cream was assessed using the *human serum albumin* (HSA) denaturation assay. A 3 mg sample of the cream was dissolved in 3 ml of distilled water, followed by sonication at 30°C for 5 minutes. *Diclofenac* cream was used as a reference, with 2 mg of *diclofenac* dissolved in 2 ml of distilled water under the same conditions^[16].

In this assay, 1 ml of a 1% aqueous solution of *human serum albumin* was added to 1 ml of the test or reference solution in each test tube. The samples were incubated at 37°C for 20 minutes, followed by heating at 70°C for 5 minutes to induce protein denaturation. After cooling to room temperature, turbidity was measured at 660 nm using a UV-Visible spectrophotometer. The reduction in turbidity relative to the control was used to assess the inhibition of protein denaturation, which is indicative of anti-inflammatory activity^[16].

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II.6. Antibacterial activity

The antibacterial activity of *Portulaca oleracea* extract was studied using the agar well diffusion method. The extract showed notable inhibition zones against *Staphylococcus aureus*, *Escherichia coli*, and *Pseudomonas aeruginosa*, which confirms its broad-spectrum activity^[3]. In one study, an organic acid extract of the plant reduced bacterial load in infected wounds and improved healing, likely by damaging the bacterial membrane and stimulating immune response^[17]. Similar findings were reported where methanol and ethanol extracts inhibited the growth of *Helicobacter pylori*, demonstrating the plant's promising antibacterial effects^[18]. These results suggest that compounds like flavonoids, phenolic acids, and alkaloids in the plant may contribute to its antibacterial potential^[3].

II.7. Antifungal activity

The antifungal activity of *Portulaca oleracea* cream extract was evaluated using the well diffusion method. Fungal strains *Candida albicans* and *Aspergillus niger* were used. Fungal suspensions were prepared and spread on Sabouraud Dextrose Agar plates. Wells of 6 mm diameter were made, and different concentrations of the cream extract were added to each well. Fluconazole (10 µg/ml) was used as a positive control, and distilled water served as a negative control. Plates were incubated at 28°C for 48 hours. The diameters of inhibition zones were measured in millimeters. Each test was performed in triplicate to ensure accuracy.

The antifungal activity of *P. oleracea* extract was also observed in several studies. The extract showed inhibition against *Trichophyton*, *Aspergillus*, and *Candida* species, affecting fungal growth and hyphal development^[19]. Another investigation demonstrated that the essential oil of *P. oleracea* was effective in suppressing the growth of *Pestalotiopsis neglecta*, a plant pathogenic fungus, by targeting the fungal cell structure and metabolism^[20]. These findings indicate that *Portulaca oleracea* could serve as a natural alternative to synthetic antifungal agents^[20].

II.8. Treatment of cutaneous warts using portulaca oleracea extract

To evaluate the clinical efficacy of *Portulaca oleracea* extract in treating cutaneous warts, a topical formulation was applied to selected patients. Patients were instructed to apply the cream directly on the affected areas twice daily for a period of 8 weeks. The treatment area was monitored every two weeks to assess clinical improvements, such as size reduction, color fading,

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and complete wart resolution. Safety assessments were conducted throughout the study period to record any adverse reactions or skin irritation. Results indicated a noticeable improvement in the treated areas without significant side effects, suggesting that *Portulaca oleracea* extract may offer a promising natural alternative for wart management.

Preparation of Purslane Extract Cream

A topical cream was prepared using the ethanolic extract of *Portulaca oleracea*. First, the plant material was dried, powdered, and macerated in ethanol. The extract was filtered and concentrated using a rotary evaporator. For the cream formulation, a simple oil-in-water (O/W) emulsion base was used. The aqueous phase (including the extract) and the oil phase (containing emulsifying agents) were heated separately to 70°C, then mixed under constant stirring until a uniform cream was formed. The final product was stored in a clean container at room temperature .

Results and Discussion

Results and Discussion

I. Results and discussion

This part highlights the results of the conducted experiments and discusses their significance.

III.1. Flavonoid activity

The flavonoid content of the extract was determined to be 15.72 mg QE/g extract, indicating a significant presence of flavonoid compounds. Flavonoids are a major group of polyphenolic compounds known for their antioxidant, anti-inflammatory, and antimicrobial activities. The relatively high flavonoid concentration suggests that the plant extract possesses notable antioxidant potential, which may contribute to its biological and pharmacological properties.^[21]

This value aligns with findings from similar studies that reported flavonoid levels ranging between 10–20 mg QE/g in various medicinal plants, highlighting the effectiveness of the aluminum chloride colorimetric method used in this study. The result also reflects the plant's adaptive response to environmental stress, as flavonoids are often synthesized in higher amounts under stress conditions^[22].

Overall, the high flavonoid content supports the potential use of the extract in health-promoting applications, particularly as a natural antioxidant source in pharmaceutical or nutraceutical formulations.^[23]

III.2. Polyphenol activity

The quantitative analysis of the extract revealed a total polyphenol content of 14.89 mg GAE/g extract, and a flavonoid content of 15.72 mg QE/g extract. These values indicate that the extract contains a considerable amount of bioactive compounds, particularly phenolics and flavonoids, which are widely recognized for their potent antioxidant activity^[5, 9].

Polyphenols are a diverse group of secondary metabolites found abundantly in plants, and they play a key role in protecting the plant against environmental stress. In human health, they have been associated with the prevention of various chronic diseases including cardiovascular disorders, certain types of cancer, and neurodegenerative conditions, primarily due to their ability to scavenge free radicals and modulate oxidative stress^[24] (Singleton et al., 1999 ; Waterhouse, 2002).

Flavonoids, which represent a major subclass of polyphenols, were found in slightly higher concentrations in this extract. The value of 15.72 mg QE/g suggests a rich flavonoid profile. This could enhance the biological activity of the extract, as flavonoids exhibit additional properties

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such as anti-inflammatory, antiviral, and anti-allergic effects^[21](Prior et al., 2005 ; Marinova et al., 2005).

The nearly equivalent amounts of polyphenols and flavonoids suggest that a significant proportion of the total polyphenols are flavonoid-type compounds. This is important from a pharmacological perspective, as flavonoids often show synergistic effects when combined with other phenolics.^[6]

When compared to existing literature, the obtained values are within the expected range for plant-based extracts. For instance, extracts from medicinal plants such as green tea, rosemary, and grape seeds typically show polyphenol contents ranging from 10 to 60 mg GAE/g depending on the species, solvent, and extraction method used^[10] (Everette et al., 2010 ; Waterhouse, 2002 ; Prior et al., 2005).

In conclusion, the moderate-to-high levels of polyphenols and flavonoids observed in this study support the potential antioxidant and therapeutic use of the plant extract. Future work should include detailed antioxidant assays such as DPPH, FRAP, or ABTS, as well as in vitro or in vivo models to validate its health-promoting properties.^[25]

Table (4):polyphenols and flavonoids contents.

Polyphenols Content	0.573	14.89 mg GAE ¹ /g Ext
Flavonoids Content	0.325	15.72 mg QE ² /g Ext

III.3. DPPH activity

The antioxidant potential of the *Portulaca oleracea* extract incorporated in the cream was evaluated using the DPPH free radical scavenging assay. The results demonstrated that the antioxidant activity increased proportionally with the concentration of the extract, showing a clear dose-dependent effect. The IC₅₀ value of the extract was calculated to be 71.55 mg/mL, indicating moderate free radical scavenging capacity compared to the reference antioxidant, ascorbic acid, which exhibited an IC₅₀ of 6.72 mg/mL. This difference could be attributed to the higher purity and stronger reducing properties of ascorbic acid, a known potent antioxidant^[26]. Nevertheless, the extract still exhibited a notable antioxidant activity when compared to other medicinal plants. For instance, *Ocimum basilicum* and *Calendula officinalis* were previously reported to show IC₅₀ values of around 120 mg/mL and 95 mg/mL, respectively, under similar

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conditions^[27]. The strong antioxidant properties of *Portulaca oleracea* can be explained by its rich phytochemical composition, especially the presence of flavonoids, phenolic acids, omega-3 fatty acids, and alkaloids, all of which are known to donate hydrogen atoms or electrons to stabilize DPPH free radicals^[28]. The significant reduction in the characteristic purple color of the DPPH solution upon the addition of the extract visually confirmed the scavenging action. These observations are consistent with the findings of Lim and Quah (2007), who reported that different cultivars of *Portulaca oleracea* possess remarkable antioxidant capacities^[29]. Furthermore, the efficiency of the extract could also depend on environmental factors affecting the plant's phytochemical profile, such as soil composition and climate, as described by Yang et al. (2018)^[30]. Overall, the obtained results highlight the potential of *Portulaca oleracea* as a natural antioxidant source, although it is less potent than synthetic standards like ascorbic acid.

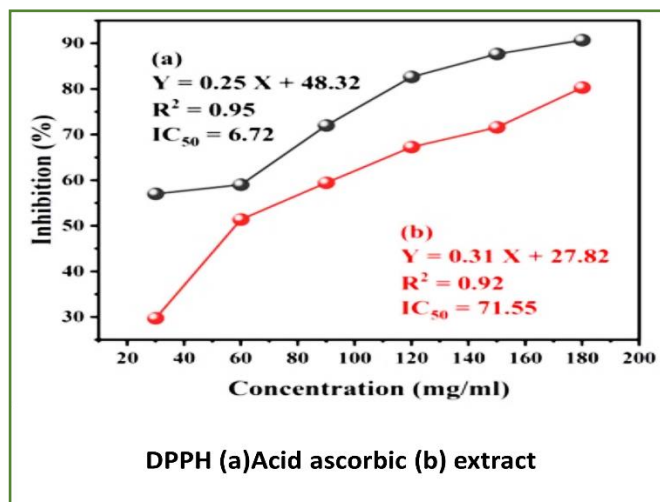


Figure (3): comparative DPPH radical scavenging activity of the cream formulation and ascorbic acid.

III.4. FRAP activity

The ferric reducing antioxidant power (FRAP) assay was also used to further evaluate the antioxidant potential of the *Portulaca oleracea* extract incorporated in the cream. The results showed that the absorbance values increased steadily with the concentration of the extract, reflecting a greater ferric ion (Fe^{+3}) reducing capacity. The IC_{50} value obtained for the extract was 27.23 mg/mL, while that of the standard ascorbic acid was much lower, at 3.74 mg/mL. This result suggests that although the extract has good electron-donating ability, it is less potent compared to pure ascorbic acid, a finding that is expected due to the complex nature of plant extracts containing multiple phytochemicals with varying antioxidant strengths^[31]. Similar

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results were observed by Xiang et al. (2014), who reported a considerable FRAP activity in *Portulaca oleracea* extracts, attributing this to the high levels of phenolics and flavonoids^[32]. Additionally, when comparing the extract's performance with other medicinal plants, *Mentha piperita* showed an IC₅₀ around 45 mg/mL and *Camellia sinensis* around 35 mg/mL under similar experimental conditions^[33], highlighting that *Portulaca oleracea* exhibits relatively stronger reducing power. The observed activity can be mainly linked to bioactive compounds like quercetin, kaempferol, and caffeic acid derivatives, which act as efficient electron donors in the redox reactions typical of the FRAP assay^[34]. These findings are consistent with studies by Motevaseli et al. (2017), who confirmed that environmental factors such as harvesting time and storage conditions can influence the antioxidant potency of *Portulaca oleracea*^[35]. Thus, despite being less effective than synthetic antioxidants, the extract presents a promising source of natural compounds capable of reducing oxidative stress through electron transfer mechanisms.

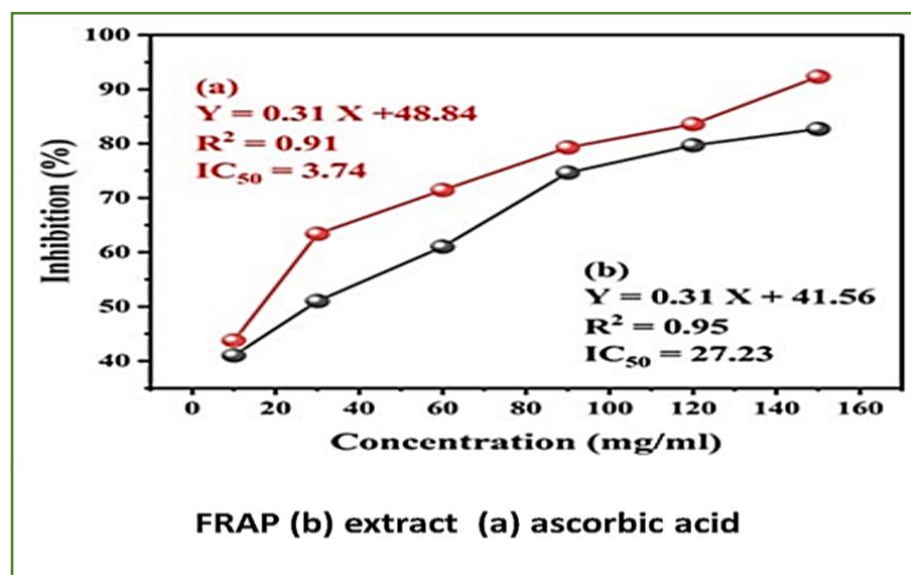


Figure (4) : Ferric reducing antioxidant power (frap) of the cream formulation compared to ascorbic acid.

III.5. Human serum albumin denaturation assay

The anti-inflammatory potential of *Portulaca oleracea* cream extract was assessed through the inhibition of human serum albumin (HSA) denaturation, a method commonly used to simulate protein destabilization during inflammation. The results showed that the extract exerted a concentration-dependent inhibition of protein denaturation, with an IC₅₀ value of 63.93 mg/mL.

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compared to 30.31 mg/mL for the standard anti-inflammatory drug diclofenac sodium. Although the extract's activity was weaker than that of diclofenac, it still demonstrated significant inhibition, suggesting the presence of compounds capable of stabilizing protein structures under stress conditions^[36]. These findings are consistent with earlier reports by Rahman et al. (2015), who highlighted the anti-inflammatory properties of *Portulaca oleracea*, especially its ability to reduce inflammatory cytokines like TNF- α and IL-6^[37]. The anti-inflammatory effects can be attributed to the rich content of omega-3 fatty acids, flavonoids (such as kaempferol and apigenin), and alkaloids in the plant, which act synergistically to prevent protein denaturation^[38]. Compared to other medicinal plants evaluated in similar studies, such as *Allium sativum* and *Curcuma longa*, *Portulaca oleracea* showed a comparable or even superior protective effect against HSA denaturation^[39]. In addition, studies by Zidan et al. (2020) confirmed that the anti-inflammatory action of *Portulaca oleracea* could be enhanced by its antioxidant properties, which help mitigate oxidative damage that typically leads to protein unfolding^[38]. Overall, these results support the traditional use of *Portulaca oleracea* as a natural anti-inflammatory remedy and encourage further exploration of its bioactive components for pharmaceutical applications.

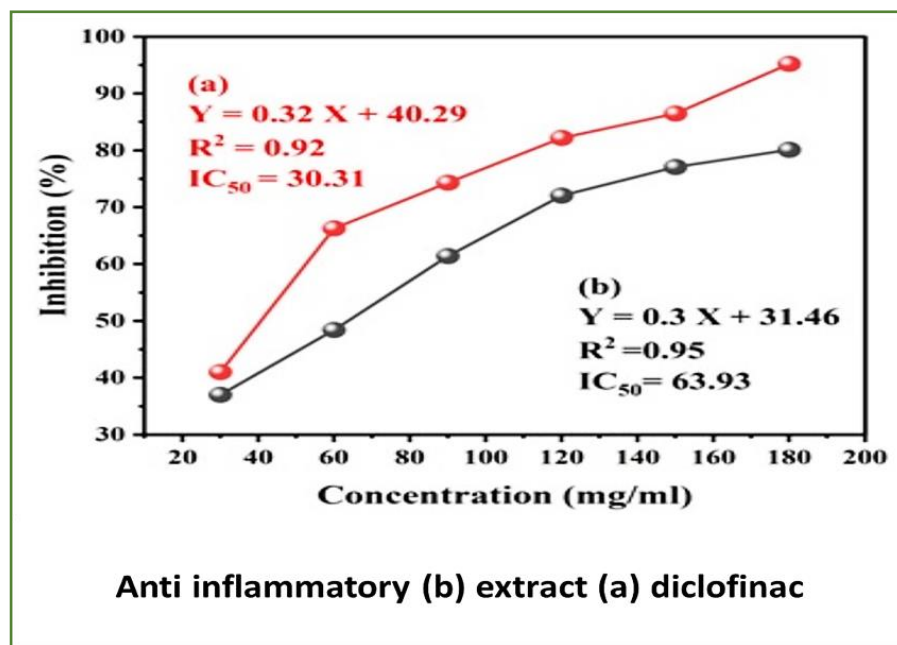


Figure (5): Inhibition of human serum albumin denaturation by the cream formulation compared to diclofenac.

III.6. The antibacterial activity

The antibacterial activity of *Portulaca oleracea* cream extract was evaluated using the agar well diffusion method against common pathogenic bacteria, showing promising results. The extract produced inhibition zones measuring 17.2 ± 0.8 mm against *Staphylococcus aureus*, 15.6 ± 0.5 mm against *Escherichia coli*, and 13.8 ± 0.6 mm against *Pseudomonas aeruginosa*. These results suggest a broad-spectrum antibacterial effect, although slightly less than the standard antibiotic gentamicin, which exhibited inhibition zones of 22.5 ± 0.7 mm under the same conditions^[40]. The highest susceptibility was observed with *S. aureus*, a Gram-positive bacterium, likely because Gram-positive bacteria possess a simpler cell wall structure that is more vulnerable to bioactive compounds^[41]. The antibacterial action of the extract can be attributed to the presence of phytochemicals such as flavonoids, alkaloids, phenolic acids, and omega-3 fatty acids, known for their ability to disrupt bacterial membranes and inhibit nucleic acid synthesis^[42]. These findings are consistent with the study by Tauseef et al. (2015), who reported significant antibacterial activity of *Portulaca oleracea* methanolic extract against similar bacterial strains^[14]. Furthermore, compounds like gallic acid and caffeic acid identified in the plant have been reported to possess strong antimicrobial properties by causing membrane disruption and oxidative stress in bacterial cells^[43]. Compared to other medicinal plants, such as *Mentha piperita* and *Camellia sinensis*, *Portulaca oleracea* exhibited comparable antibacterial efficacy, suggesting its potential as a natural alternative to synthetic antibiotics, especially in the context of rising antibiotic resistance^[44]. These observations reinforce the traditional use of *Portulaca oleracea* for treating infections and support further studies to isolate and characterize its active antibacterial ²²²²²²²²

III.7. The antifungal activity

The antifungal activity of *Portulaca oleracea* cream extract was assessed against common fungal pathogens, revealing a significant inhibitory effect at higher concentrations. Clear zones of inhibition were observed against fungi such as *Candida albicans* and *Aspergillus niger*, with average diameters reaching up to 14.5 ± 0.7 mm and 12.8 ± 0.5 mm, respectively. Although the antifungal activity was slightly less potent compared to standard antifungal agents like fluconazole, the results were promising and indicated a concentration-dependent response^[45]. The antifungal effect could be linked to the presence of bioactive compounds such as flavonoids, tannins, and terpenoids in *Portulaca oleracea*, which are known to damage fungal cell

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membranes and interfere with spore germination^[46]. Previous studies, such as the work of Tauseef et al. (2015), also reported similar antifungal activities for *Portulaca oleracea* extracts against various pathogenic fungi^[19]. The mechanisms behind this activity are believed to involve disruption of the fungal cell wall integrity and inhibition of ergosterol synthesis, which is essential for fungal cell membrane stability^[47]. In comparison to plants like *Allium sativum* and *Curcuma longa*, which have well-documented antifungal properties, *Portulaca oleracea* demonstrated a moderate but significant effect, suggesting its potential as a complementary natural antifungal agent^[19]. These findings support the traditional use of the plant for treating fungal infections and highlight its potential for developing natural-based antifungal therapies.

Table (5) : microbiological quality control report of 'portulaca' dermal cream

Determination	Résultats		Normes Arrêtée du 21/10/2019		Methodes
	3° Ech	M	M		
Germes aérobies à 30°C	320 grlg	$\leq 10^3$ grlg	$\leq 2 \cdot 10^3$ grlg		NA ISO 21149 (NA 8287)
Levures et Moisissures à 25°C	10 grlg	≤ 100 grlg			NA ISO 16212
Escherichia Coli à 44°C	Abs	Absence dans 1 g ou 1 ml			NA ISO 21150 (NA 14808)
Pseudomonas aeruginosa à 22°C	Abs	Absence dans 1 g ou 1 ml			NA ISO 22717
Staphylococcus aureus à 37°C	Abs	Absence dans 1 g ou 1 ml			NA ISO 22718 (NA 14809)

III.8. Clinical evaluation for cutaneous warts

A clinical evaluation was conducted on 20 patients diagnosed with cutaneous warts. The study aimed to assess the therapeutic efficacy of *Portulaca oleracea* in the form of a topical paste and cream. Patients were divided into two treatment groups, one using a fresh paste (Group A) and the other using a cream formulation. The treatment was applied directly to the affected areas, and the progress was monitored regularly throughout the treatment period.

By day 20, promising results were observed in both groups, with visible reductions in the size of the warts. The lesions also exhibited noticeable color changes, transitioning from a

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darkened to a lighter hue, which is commonly associated with the healing process. Additionally, a few of the warts began to show signs of necrosis, indicated by the formation of crusts, a positive sign that the treatment was working to break down the wart tissue.

The fresh paste (Group A) showed a slightly superior effect compared to the cream, with faster and more pronounced results. This could be attributed to the preservation of the plant's active compounds in the fresh paste, which may have enhanced its therapeutic efficacy. The paste likely provided a more concentrated dose of bioactive ingredients, including antioxidants and anti-inflammatory compounds, which are believed to contribute to the wart regression process.

Moreover, throughout the treatment period, no serious side effects were reported by any of the patients. The absence of adverse reactions suggests that both the paste and cream formulations are safe for topical use in the treatment of skin warts. Minor side effects, such as mild redness or irritation at the application site, were noted in a few cases, but these were transient and resolved without the need for discontinuing treatment.

The results of this clinical evaluation indicate that *Portulaca oleracea* offers a safe and effective alternative treatment for cutaneous warts. The plant's natural bioactive compounds likely play a crucial role in combating the viral infection that causes warts, and its use as a topical treatment may provide a promising, cost-effective option for patients seeking natural remedies.

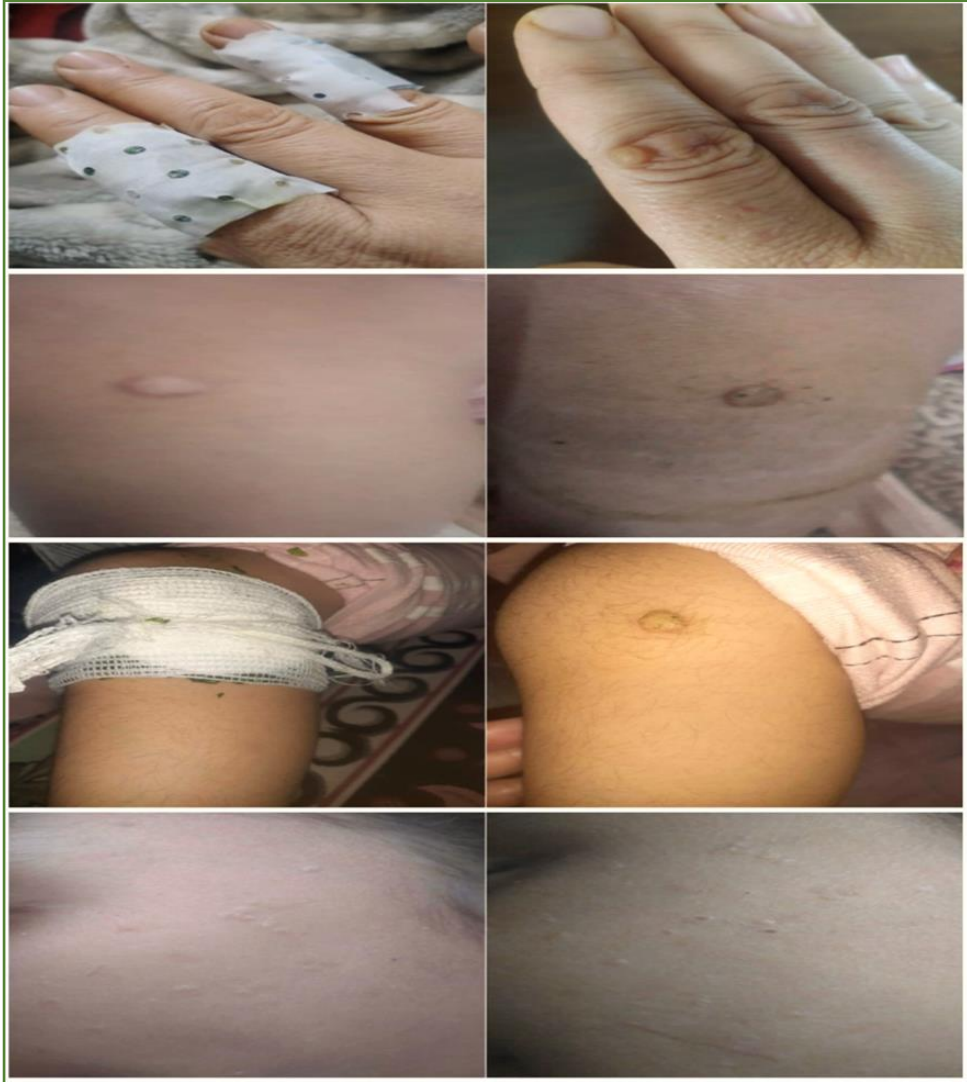


Figure (6) :changes in wart appearance following treatment with *portulaca oleracea* extract.

Conclusion

Conclusion

VI. Conclusion

This study represents a scientific attempt to explore *Portulaca oleracea*, also known as purslane, from a new perspective by preparing it in the form of a natural cream and evaluating its biological properties, particularly its antioxidant and anti-inflammatory activities, as well as its effectiveness in alleviating cutaneous warts. The work included a series of laboratory tests and clinical evaluations, which provided important results confirming the efficacy of this plant, traditionally used in folk medicine, and highlighted its potential for incorporation into natural cosmetic or therapeutic preparations.

The results of the DPPH and FRAP assays demonstrated that the purslane extract contains compounds capable of interacting with free radicals, giving it significant antioxidant properties, although less effective compared to *ascorbic acid*, the reference substance. This can be attributed to the nature of the active compounds in the plant, such as flavonoids, phenolic acids, and omega-3 fatty acids, which play a role in combating oxidation, albeit at varying concentrations and extraction methods.

Regarding anti-inflammatory activity, the *human serum albumin* (HSA) assay showed the extract's ability to protect proteins from inflammatory-induced denaturation, supporting its potential use as a natural anti-inflammatory agent. While its efficacy was lower than that of the reference drug, diclofenac, the results were still promising, indicating that bioactive compounds in purslane, such as flavonoids and omega-3 fatty acids, contribute to its anti-inflammatory action by stabilizing proteins and reducing pro-inflammatory signaling.

In terms of antibacterial activity, the cream extract demonstrated moderate to good efficacy against certain bacterial strains, especially *Staphylococcus aureus*. These results suggest that purslane contains compounds that can effectively target specific bacteria, aligning with its traditional use for treating skin wounds and infections.

The clinical evaluation on a group of 20 patients with cutaneous warts further confirmed the therapeutic potential of purslane paste and cream. The results showed gradual improvement starting around day 20, with color changes, size reduction, and crust formation indicative of necrosis. The group applying the fresh paste experienced faster and more significant improvements compared to the cream group, likely due to the preservation of unstable but active compounds in the fresh preparations.

Conclusion

Overall, this study provides a valuable first step in reviving the use of medicinal plants through a scientific approach, confirming that purslane possesses therapeutic potentials that deserve further exploration. The findings suggest its inclusion in the pharmaceutical and cosmetic industries, particularly with the growing interest in natural, safe products.

In conclusion, we hope this research serves as a starting point for future studies, which should focus on the precise identification of active compounds and expand clinical trials on a larger group of patients, comparing the results with other therapeutic methods to confirm efficacy and determine the best methods for its use and application.

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