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PHYTOCHEMICAL INVESTIGATION OF ALOEVERA (*ALOE BARBADENSIS* MILLER) LEAVES, FORMULATION AND EVALUATION OF ALOEVERA GEL

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Keywords:

Phytochemical investigation, Evaluation parameters, *Aloe barbadensis* Miller, Aloe vera gel formulation

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ABSTRACT

The gel extracted from the Aloe vera plant is well-known for its healing, beauty, and health properties. It contains a variety of beneficial elements, including vitamins, minerals, amino acids, and antioxidants. Aloe vera gel is particularly recognized for its ability to heal skin, reduce inflammation, and provide moisture. It is often utilized for treating burns, wounds, and skin problems, as well as serving as a natural moisturizer. Beyond skin care, Aloe vera is being investigated for its possible benefits for digestion, immune health, and internal anti-inflammatory effects. Recent research has indicated encouraging findings about its antioxidant capabilities and its potential to help manage blood sugar levels. Nonetheless, despite the widespread endorsement of Aloe vera gel for health benefits, scientific evidence to support many of these proposed effects is still under investigation. Additional studies are necessary to gain a comprehensive understanding of how Aloe vera gel works, its safety, and its effectiveness in different medical and cosmetic uses.

INTRODUCTION

Concept of Herbal Drugs

Herbal drugs, also known as botanical medications or phyto medicines, refer to therapeutic substances derived from plants, plant parts, or plant extracts. These substances have been the foundation of medical treatment for millennia, spanning across diverse cultures and civilization. Unlike synthetic drugs, which are often single chemical entities, herbal drugs represent a complex mixture of primary and secondary metabolites that work synergistically to provide a therapeutic effect. The World Health Organization (WHO) defines herbal medicines as including herbs, herbal materials, herbal preparation and finished herbal products that contain active ingredients from parts of plants, other plant materials, or combinations. The resurgence of interest in herbal drugs in recent years is driven by the perception that natural products are safer and have fewer side effects compared to their synthetic counterparts

Key Characteristics:

Derived from natural biological sources.

Contains a complex matrix of active compounds.

Used in traditional systems like Ayurveda, Unani and TCM (Traditional Chinese Medicine).

Importance in Modern Medicine

In the contemporary era, herbal drugs have transitioned from traditional folklore to mainstream scientific research. Modern medicine owes a significant portion of its pharmacopeia to plant-derived compounds. For instance, drugs like Aspirin (from Willow bark), Digoxin (from Foxglove), and Taxol (from Pacific Yew) are classic examples of modern medicines rooted in herbal sources. The importance of herbal medicine today lies in several factors:

Lead Identification: Plants serve as a" chemical library" for discovering new drug molecules.

Reduced Toxicity: Many herbal preparations are better tolerated by the human body over long periods, especially for chronic conditions.

Sustainability: Herbal drugs often provide a more sustainable and cost-effective alternative in developing regions where synthetic medications may be expensive or inaccessible.

Holistic Approach: Modern phyto therapy focuses on treating the root cause of the ailment rather than just suppressing symptoms.

Overview of Aloevera

Aloevera (L.) Burm. f., belonging to the family Asphodelaceae (Liliaceae), is a perennial succulent plant known for its fleshy green leaves. Often referred to as the "Plant of Immortality" by ancient Egyptians and "the silent healer" by others, it has been used for over 5,000 years. The plant is characterized by its triangular, fleshy leaves with serrated edges. Morphologically, the leaf consists of three main layers. (3, 5)

1. The Rind: The outer protective layer that synthesizes carbohydrates and proteins.

2. The Sap (Latex): A bitter yellow layer containing anthraquinones (like aloin), which possess laxative properties.

3. The Mucilaginous Gel: The inner clear fillet containing approximately 99% water with the remainder consisting of vitamins, enzymes, minerals, sugars, and amino acids.

Applications in Pharmaceuticals and Cosmetics

Aloevera is one of the most commercially utilized plants globally due to its diverse biological activities. Its applications span across multiple industries. (8, 13)

A. Pharmaceutical Uses

In the pharmaceutical sector, Aloevera is valued for its wound-healing and anti-inflammatory properties. The acemannan (a complex polysaccharide) found in the gel stimulates macrophage activity and accelerates tissue repair. (3, 14)

Dermatology: Used in treatments for burns, psoriasis, and radiation-induced dermatitis.

Gastrointestinal Health: Used to soothe stomach ulcers and act as a mild laxative (latex).

Antimicrobial Activity: Shows efficacy against certain bacteria and fungi, making it a common ingredient in antiseptic creams.

B. Cosmetic Uses

The cosmetic industry is the largest consumer of Aloevera gel. Its moisturizing and anti-aging properties make it a staple ingredient in skin care formulations.

- Skin Care: Used in moisturizers, sunscreens, and anti-acne gels because it penetrates the skin deeply to provide hydration.
- Hair Care: Found in shampoos and conditioners to treat dandruff and promote scalp health.
- Anti-Aging: Aloevera stimulates collagen and elastin fiber production, making the skin more elastic and less wrinkled.

REVIEW OF LITERATURE

Historical Perspectives and Global Usage

The therapeutic potential of Aloevera has been documented since ancient times. Literature reviews indicate its presence in the Ebers Papyrus of 1550BC, where it was noted for its use in treating skin infections and digestive issues. In the Indian traditional system, Ayurveda, the plant is known as 'Ghritkumari' and is categorized as a cooling agent with rejuvenating properties. Modern scientific inquiry in to the plant began in the mid-1930s when researchers started investigating its efficacy in treating radiation burns, marking the beginning of its transition in to standardized pharmaceutical science (13,23)

Previous Phytochemical Investigations

Phytochemical screening is the fundamental step in identifying the bioactive constituents of any herbal drug. Over the past decades, several researchers have identified more than 75 potentially active constituents in Aloevera, including vitamins, enzymes, minerals, sugars, lignin, saponins, salicylic acids, and amino acids. Literature suggests that the primary bioactive compound responsible for the gel's healing property is Acemannan, a long-chain polymer of acetylated mannose (3, 14). Other studies have highlighted the presence of Aloin (Barbaloin) and Emodin in the latex layer, which provide potent antioxidant and laxative effects. The synergistic action of these compounds is believed to be the reason why the whole plant extract often outperforms isolated constituents in clinical trials.(14,21)

Analysis of Research Studies (Global Findings)

Study 1: Wound Healing Efficacy

Davis et al.(1994) conducted a comprehensive study on the wound healing activity of Aloevera gel. The research demonstrated that topical application of the gel increased the collagen content of the granulation tissue and changed the collagen composition, resulting in faster wound contraction. The study concluded that Aloevera works by increasing the cross-linking of collagen, thereby enhancing the tensile strength of the skin (2)

Study 2: Antioxidant and Anti-inflammatory Properties

A study by Hamman (2008) reviewed the pharmacological properties of Aloe gel and identified that the anti-inflammatory action is mediated through the inhibition of the cyclooxygenase (COX) pathway. The researchers found that the C-glucosyl chromone present in the gel reduces prostaglandin synthesis, effectively decreasing swelling and pain in localized inflammatory conditions (3, 18)

Study 3: Antimicrobial Spectrum

Research published in the Indian Journal of Dermatology investigated the antimicrobial effect of Aloevera against common pathogens like Staphylococcus aureus and Candida albicans. The study confirmed that the inner gel contains pyrocatechol and cinnamic acid derivatives that inhibit microbial growth, making it a viable candidate for topical antiseptic formulations.

Study 4: Glycemic Control in Diabetes

Tanaka etal. (2006) conducted clinical trials to evaluate the effect of phytosterols derived from Aloe vera on blood glucose levels.(6) The results indicated a significant reduction in fasting blood glucose levels in Type II Diabetic patients.(6). The research suggests that Aloe components may improve insulin sensitivity, opening avenues for its use as a nutraceutical in metabolic disorders (6, 22)

Study 5: Photo protective Activity

Studies on UV radiation protection (2012) revealed that Aloevera gel forms a protective layer on the skin when applied topically (13, 23).It induces the production of an antioxidant protein called metallothionein in the skin, which prevents the suppression of super oxide dismutase and glutathione per oxidase, thereby protecting the skin from oxidative stress caused by sunlight.(15,23)

Evaluation and Preparation Studies of Aloe Gel

The literature concerning the preparation of Aloe gel emphasizes the importance of the stabilization process. Because the gel is highly susceptible to oxidation and microbial spoilage once the leaf is cut, researchers like Ramachandra and Rao (2008) have detailed various stabilization techniques, including cold processing and high-temperature short-time (HTST) treatment. Evaluation parameters for the gel typically include pH determination, viscosity measurement, spreadability and moisture content. Previous reports suggest that a high-quality gel should maintain a pH between 4.5and 5.5 to be compatible with human skin.

Scientifically Proven Benefits of Aloevera

Modern pharmacological screening has validated several traditional claims regarding the benefits of Aloe vera.

Dermatological Benefits: Scientific evidence confirms that Aloevera increases the water content of the stratum corneum. It acts as a humectants by trapping moisture, which is vital for treating dry skin conditions.

Immunomodulatory Effects: Recent literature highlights the role of Aloevera polysaccharides in modulating the immune system. Acemannan has been shown to activate macrophages and stimulate the release of cytokines[14,22].

Dental Health: Comparative studies between Aloevera tooth gels and standard fluoride toothpastes have shown that Aloe is equally effective at controlling plaque and gingivitis[13,21].

Gastro protective Properties: Animal model studies have demonstrated that Aloevera extract can reduce gastric acid secretion and increase the production of gastric mucus[13, 22].

Summary of Literature Findings

The extensive review of literature confirms that Aloevera is a reservoir of diverse phytochemicals with proven therapeutic benefits. While traditional use provides a strong foundation, modern clinical studies have validated its efficacy in wound healing, inflammation control, and glucose regulation. However, the literature also points out a gap in the standardization of gel preparation techniques, which justifies the current project's aim of evaluating and preparing an optimized Aloe vera gel formulation.

AIM AND OBJECTIVES

Aim

To perform phytochemical investigation of Aloevera (*Aloe barbadensis* Miller) leaves, formulation and evaluation of aloevera gel.

Objectives

- To perform the collection and authentication of *Aloe barbadensis* Miller leaves.
- To extract the mucilaginous gel from the inner core of the leaves using the filleting method.
- To carryout preliminary phytochemical screening of the extract to identify secondary metabolites such as alkaloids, glycosides, tannins and flavonoids.
- To formulate a herbal gel using various concentrations of gelling agents (like Carbopol 934 or HPMC).
- To evaluate the prepared gel for

physicochemical parameters including pH, viscosity, Spreadability and extrudability.

- To assess the stability of the formulation and its suitability for topical skin application.

DRUG PROFILE: ALOEVERA

Taxonomical Classification

Kingdom	Plantae
Clade	Angeosperms
Order	Asparagales
Family	Asphodelaceae
Genus	Aloe
Species	*Aloe barbadensis* Miller

Synonyms and Vernacular Names

Synonyms: Aloe indica Royle, Aloeperfoliata, Aloevulgaris. Vernacular Names:

Sanskrit: Ghritkumari, Kanya

Hindi: Gwarpatha, Ghikanvar

Marathi: Korphad

English: Curacao Aloe, Barbados Aloe

Tamil: Kattarhuazhai

i) Geographical Source

Native to North Africa, Southern Europe and the Canary Islands. It is now widely cultivated in subtropical and tropical regions across India, USA (Florida, Texas),Mexico, and China.

ii) Morphological Characters

iii) Type: Perennialsucculent herb.

a) Leaves: Fleshy, triangular, sessile, 30-50 cm long, pea-green color with white spots in young plants.

iv) Margin: Spiny teeth at regular intervals.

v) Flower: Yellow to bright orange, arrange dinaraceme.

i. Chemical Constituents

Contains Anthraquinone glycosides (Aloin A and B), polysaccharides (Acemannan), vitamins (A,C,E,B 12), enzymes (Bradykinase) and minerals (Calcium, Magnesium, Zinc) (3,19)

C. Pharmacological Activities & Medicinal Uses

b. Possesses anti- inflammatory, antimicrobial, wound healing, antioxidant and moisturizing properties. Used for treating burns, psoriasis, constipation (latex) and as a base in cosmetic formulations. (13,22)

c. Part Used: Fleshy leaves (Inner gel and dried juice / latex).

PLANT PROFILE

Biological Source

Aloevera consists of the dried juice of the leaves of Aloe barbadens is Miller (also known as Aloe vulgar is Lamarck). It is a succulent plant belonging to the family Asphodelaceae (formerly Liliaceae). The plant produces two main medicinal substances: the Aloe Gel which is the mucilaginous liquid obtained from the parenchymatous cells of the inner leaf and the Aloe Latex (or juice) which is the bitter yellow liquid found in the pericyclic tubules just beneath the leaf skin. For this project, the focus remains primarily on the inner parenchymatous gel.

Taxonomical Classification

Kingdom	Plantae
Division	Spermatophyta
Subdivision	Angiospermae
Class	Monocotyledone
Order	Liliales
Family	Asphodelaecae
Genous	Aloe
Species	Barbadensis

Morphology (Organoleptic Evaluation)

The morphological characteristics of the Aloevera plant are distinctive and serve as

primary identification markers in pharmacognosy (7, 20)

Macro-morphology of the Whole Plant

a. Appearance: It is a stem less or very short-stemmed succulent plant growing up to 60-100 cm tall.
b. Leaves: The leaves are thick, fleshy and lanceolate. They are arranged in a rosette pattern. The color is typically green to grey-green, often with white spots on the upper and lower stem surfaces in young plants.
c. Margins: The leaf margins are armed with small, white, prickly teeth.
d. Flowers: Produced on a spike up to 90 cm tall, each flower being pendulous, with a yellow tubular corolla (20)

b) Micro-morphology of the Leaf Section

A transverse section of the leaf reveals three distinct layers (3,5)

a) Outer Rind: A thick, protective cuticle layer containing chloroplasts for photosynthesis.
b) Pericyclic Layer: Contains the vascular bundles and the specialized cells that produce the bitter, yellow, hydroxyanthraquinone-rich latex.
c) Parenchymatous Core: The innermost part consisting of large thin-walled cells that store the clear, mucilaginous gel (3)

C. Chemical Constituents

The chemical l profile of Aloevera is highly complex, containing over 200 different biological compounds (3, 13). These are categorized as follows:

- Polysaccharides (Gums and Mucilages): These are the most important constituents of the gel. Acemannan (a beta-1,4-acetylatedglucomannan) is the primary functional component responsible for viscosity and healing properties. (3,14)
- Anthraquinones: Mainly found in the latex layer. These include Aloin A (barbaloin) and Aloin B (isobarbaloin) (10, 15). These compounds possess potent laxative and antimicrobial effects (15)
- Enzymes: Contains approximately 8 enzymes, including amylase, lipase and bradykinase. Bradykinase helps reduce excessive inflammation when applied topically (13).
- Vitamins and Minerals: Richin Vitamin A, C and E (antioxidants) Vitamin B12, and folic acid. Essential minerals include Calcium, Magnesium, and Zinc.(22)
  - Amino Acids: Provides 20 of the 22 human-required amino acids and 7of the 8 essential amino acids.
  - Others: Includes Salicylic acid (anti-inflammatory), Saponins (cleansing agent), and Lignin (enhancing penetration).

MATERIALS AND METHODS

Collection and Authentication

Fresh, healthy and mature leaves of *Aloe barbadensis* Miller were collected from a local botanical garden or authorized herbal nursery. The leaves were selected based on their size typically 30-50cm in length) and succulent appearance, ensuring they were free from fungal infections or mechanical damage[4,16].

Procedure for Collection:

1. The leaves were harvested in the early morning hours to maintain maximum moisture content.
2. A sharp, sterile stainless steel knife was used to cut the leaves transversely near the base of the plant.
3. The harvested leaves were immediately placed in an upright position to allow the yellow latex (aloins) to drain out or wiped clean with distilled water.
4. The leaves were transported to the laboratory in air-tight polyethylene bags to prevent wilting and moisture loss.

Authentication:

The plant material was authenticated by a qualified botanist and pharmacognosist. Authentication involves comparing the morphological and Organoleptic characters with the standard descriptions mentioned in the Indian Pharmacopoeia (IP) and other standard taxonomic texts.[1, 20].

Extraction of Aloe Vera Gel

The extraction process is critical to ensure the purity of the inner parenchymatous gel and to avoid contamination from the anthraquinones present in the outer rind.[3,21].

The Filleting Method (Cold Processing):

1. De-thorning: The lateral spiny margins were removed by cutting thin strips along each edge.
2. Slicing: The leaf was sliced longitudinally or the upper rind was peeled away to expose the inner jelly.
3. Scooping: The clear, colorless inner pulp was carefully scooped out using a sterile spatula, ensuring no green rind was included.
4. Homogenization: The pulp was homogenized using a laboratory blender at low speed to
5. As an antioxidant and 0.1% Sodium benzoate as a preservative. The stabilized extract was stored at 4° break the fibrous structure.
6. Filtration: The mixture was filtered through a muslin cloth to remove cellular debris.

Stabilization:

Since Aloe gel is highly susceptible to enzymatic browning and oxidation, it was stabilized by adding 0.1% Citric acid Cinamber-colored glass containers.

Preliminary Phytochemical Screening

The extracted gel was subjected to various qualitative chemical tests to identify the presence of primary and secondary metabolites[7,9].

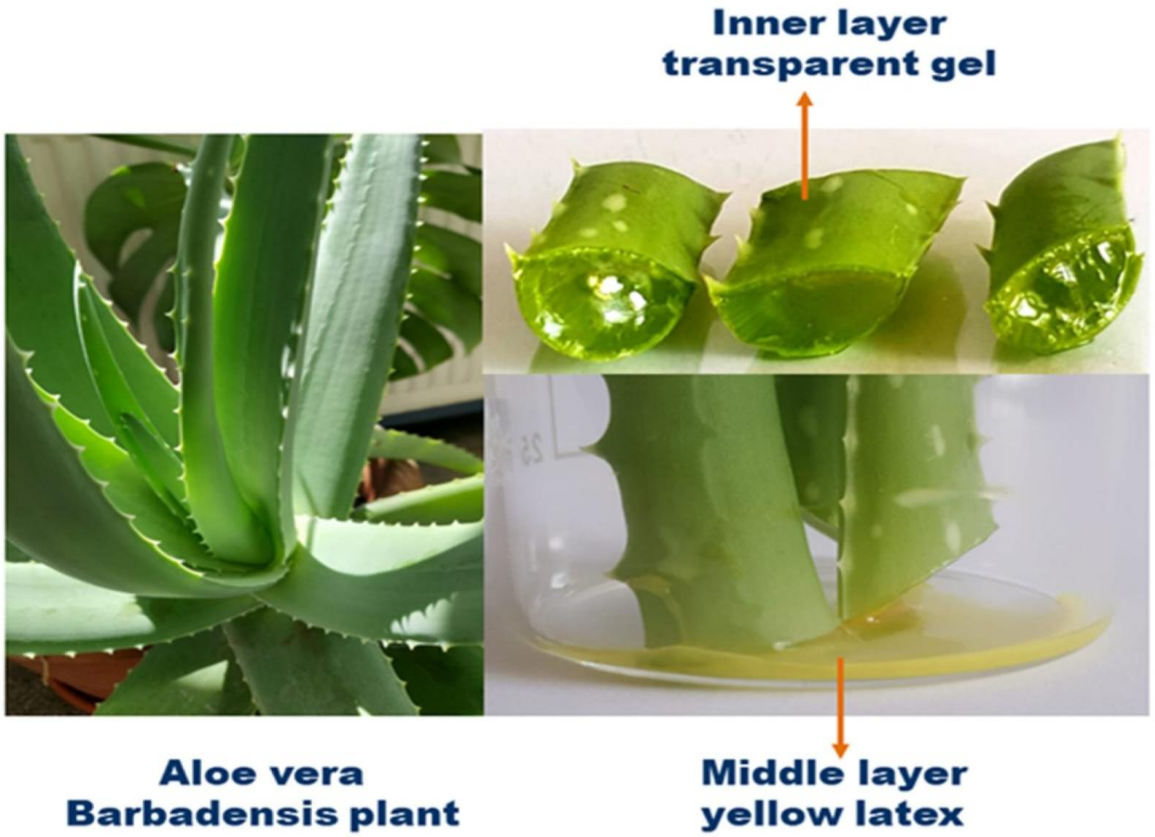
- Carbohydrates: Confirmed by Molisch's Test (violet ring) and Fehling's Test (brick-red precipitate)[9,21].
- Glycosides: Borntrager's Test and Modified Borntrager's Test indicated the presence of anthraquinones and Aloin[7,15].
- Alkaloids: Tested using Mayer's Reagent and Dragendorff's Reagent[7].
- Saponins: Confirmed by the formation of a stable honeycomb froth (Froth Test)[13].
- Phenolics & Tannins: Detected using Ferric Chloride and Gelatintests[9].
- Proteins &Amino Acids: Detected using Ninhydrin and Biurettests[13].

Chemicals and Apparatus

Name of Chemical	Grade	Purpose
Distilled Water		
Cleaning	Laboratory Grade	
Methanol / Ethanol (95%)	Solvent / A.R. Grade	Phytochemical Extraction
Carbopol 934		

Name of Chemical	Grade	Purpose
Sodium Benzoate Citric Acid	A.R.Grade A. R. Grade	Preservative Antioxidant/pHRegulator

Instrument	Purpose
Digital pH Meter	To measure acidity /alkalinity
Brookfield Viscometer	To determine viscosity of the gel
Electronic Analytical Balance	Precise weighing of materials
Laboratory Blender	Homogenization of gel pulp



FORMULATION OF ALOEVERA GEL

Formulation Design

The success of a topical gel formulation depends on the selection of compatible excipients that can maintain the stability of the active phytochemicals while ensuring aesthetic appeal and ease of application. The following table details the master formula designed for the preparation of 200 ml of Aloe vera gel.

Ingredient	Quantity	Pharmacological Role
Aloe Vera Extract	20g	Active Ingredient
Carbopol934	1.0g	Gelling / Thickening Agent
Glycerin	10g	Humectant /Moisturizer
Propylene Glycol	5g	Solvent / Skin Conditioner
Methyl Paraben	0.2g	Preservative (Anti-bacterial)
Propyl Paraben	0.02g	Preservative (Anti-fungal)
Triethanolamine	q.s. pH Adjuster / Neutralizer Distilled Water q.s. to 200 ml Vehicle	

Preparation Procedure

The formulation was prepared using the Cold Dispersion Method. This method is preferred to avoid the thermal degradation of the thermo-sensitive acemannan and enzymes present in the Aloe extract [3,5].

Step1: Preparation of Gelling Base

1. Accurately weigh1.0g of Carbopol 934.

2. Disperse the Carbopol in approximately100 ml of distilled water. The powder should be sprinkled slowly on to the surface of the water while stirring continuously at high speed using a magnetic stirrer to avoid the formation of lumps (clumping).
3. Allow the dispersion to hydrate for24 hours at room temperature to ensure complete swelling of the polymer.

Step 2: Dissolution of Preservatives and Excipients

1. Dissolve the weighed quantities of Methyl Paraben and Propyl Paraben in Propylene Glycol. Gentle warming may be applied if necessary.
2. Add Glycerin to this mixture and stir until a homogenous solution is formed.
3. Incorporate this preservative mixture into the hydrated Carbopol dispersion with constant stirring[19].

Step 3: Incorporation of Active Ingredient

1. Add 20 g of freshly extracted and stabilized Aloe vera extract slowly to the mixture[21].
2. Continue stirring for15-20 minutes to ensure uniform distribution within the polymer matrix.

Step 4: Neutralization and Gel Formation

1. Add Triethanolamine (TEA) drop wise while monitoring the pH[1,5].
2. As the pH reaches the range of 6.0 to 7.0, the Carbopol chains expand due to electrostatic repulsion, resulting in the formation of a clear, transparent gel[19].

Step 5: Volume Adjustment

Adjust the final volume to 200 ml using distilled water. The gel is stirred slowly to remove air bubbles and transferred to a clean wide-mouth amber-colored container.

EVALUATION OF PREPARED GEL

The prepared Aloevera gel was subjected to various physicochemical evaluation parameters to ensure its quality, safety and efficacy for topical application[5,13].The following methods were employed:

Physical Appearance and Homogeneity

The formulated gel was visually inspected for its color, clarity and the presence of any foreign particles. Homogeneity was tested by visual inspection after the gel had set in the container and by rubbing a small amount between the thumb and index finger to check for coarse particles or aggregates (19)

Measurement of pH

The pH was determined using a digital pH meter One gram of gel was dissolved in 100 ml of distilled water and stored for two hours before the electrode was immersed for reading. For topical preparations the pH should be compatible with the skin's natural pH (range 5.0–7.0) to prevent irritation (1,13)

Viscosity Measurement

Viscosity is a key parameter affecting the pourability and application of the gel. It was measured using a Brookfield Viscometer (Spindle No.T-95). The gel was allowed to settle at room temperature for 30 minutes before the spindle was rotated at a specific speed (e.g.50 rpm) to record readings in centipoises (cP) (5,19)

Spreadability

Spreadability denotes the area to which the gel readily spreads upon skin application. A 0.5g sample was placed between two glass slides. A100g weight was applied for 5 minutes to provide a uniform film. The top slide was then subjected to a specific pull weight and the time taken for the slides to separate was recorded.(21)

$$S = (M \times L) / T$$

Where: S=Spreadability (g.cm/sec), M=Weight (g), L=Slide length (cm), T=Time (sec)

Skin Irritation Test (Patch Test)

To evaluate safety, a skin irritation test was per formed by applying the gel to a 2 sq.cm area on the dorsal surface of the hand. The area was observed for erythema (redness), edema, oritchingat intervals of 2,6,12 and 24hours. If no irritation occurs within 24 hours, the formulation is considered safe for topical use.(13,23) .

Extrudability Study

The gel was filled into a collapsible aluminum tube. The force required to extrude the gel when a constant weight was applied to the crimped end was measured to assess the ease of extrusion (19)

Stability Study

The formulation was stored at 4°C, Room Temperature, and 40°C for one month. The gel was periodically checked for changes in pH, viscosity, and appearance to ensure the formulation remains stable over time (13).

RESULTS

Preliminary Phytochemical Screening

The qualitative chemical analysis of the Aloevera leaf extract revealed the presence of various secondary metabolites. The results of the specific phytochemical tests are summarized in the table below (7, 9)

Sr. No.	Phytochemical Test	Specific Test Name	Result
1	Carbohydrates	Molisch's Test	Positive (+)
2	Reducing Sugars	Fehling's Test	Positive (+)
3	Glycosides	Borntrager's Test	Positive (+)
4	Alkaloids	Mayer's Test	Negative(-)
5	Saponins	Froth Test	Positive (+)
6	Tannins	Ferric Chloride Test	Positive (+)
7	Flavonoids	Shinoda Test	Positive (+)
8	Proteins	Biuret Test	Positive (+)
9	Amino Acids	Ninhydrin Test	Positive (+)
10	Phytosterols	Salkowski Test	Positive (+)

Note: (+) indicates Presence,(-) indicates Absence.

Physicochemical Evaluation of Formulated Gel

The prepared Aloevera gel formulation was evaluated for various parameters to ensure its suitability for topical use. The findings are tabulated below as the mean of three independent observations (n=3) (1, 19)

Sr. No.	Parameter	Observation / Result
1	Color	Clear / Transparent
2	Odour	Characteristic
3	Clarity	Excellent
4	Homogeneity	Excellent (No aggregates)
5	pH	6.4±0.2
6	Viscosity (at 50rpm)	3850±50cP
7	Spreadability	12.85g.cm/sec
8	Extrudability	Excellent
9	Skin Irritation	Non-irritant
10	Stability (at RT)	Stable

DISCUSSION

The present study focused on the phytochemical investigation of *Aloe barbadensis* Miller and the development of a stable herbal gel formulation. The results provide a comprehensive understanding of the plant's chemical profile and the suitability of the formulated gel for topical use[13].

Phytochemical Significance

Phytochemical screening confirmed the presence of secondary metabolites including carbohydrates, glycosides, flavonoids, tannins and saponins. The confirmation of anthraquinone glycosides (Aloin) via Borntrager's test aligns with literature stating that Aloespeciesarerichin phenolic compounds. Flavonoids and tannins contribute potent antioxidant and anti-inflammatory activities which help neutralize free radicals and accelerate skin healing. The absence of alkaloids is consistent with successful isolation of the parenchymatous gel without contamination from other tissues.(13, 21)

Physicochemical Interpretation

The gel exhibited a pH of 6.4,fallingwithin the ideal physiological range for human skin (5.5to7.0),ensuring compatibility and preventing irritation(1,5,13).Viscosity (3850cP) and Spreadability (12.85g.cm/sec) are crucial rheological parameters achieved through the neutralization of Carbopol 934with Triethanolamine. The sevalues indicate that the gel can be easily applied with lows hear, ensuring a uniform thin film for effective drug delivery and patient compliance. 19, 21).

Correlation with Literature

Findings are harmonious with established studies by Davisetal and Hamman regarding the mucilaginous nature of the Aloegenus. Excellent extrudability and homogeneity suggest that Carbopol 934 and Glycerin were used in optimal ratios. Stability at room temperature indicates that the preservative system (Methyl and Propyl Paraben) and the antioxidant (Citric acid) effectively prevented microbial growth and oxidative browning. (5,13)

Rationale for Results

Success is attributed to the Cold Processing Technique, which prevents the degradation of thermo-sensitive polysaccharides like Acemannan. Triethanolamine was critical for expanding Carbopol polymerchains to create a stable matrix that trapped the Aloe extractandglycerin.Thenon-irritantnatureconfirmedbythepatchtestis likelydueto the high purity of the gel and the absence of yellow latex (aloins) in the final formulation. (13,23)

Conclusion of Discussion

In conclusion, the data suggests that the formulated Aloevera gel is a stable, safe and effective vehicle for topical delivery. The study validates the traditional use of Aloevera and provides a scientific bas is for its formulation into a modern pharmaceutical product.(13,15)

CONCLUSION

The present study successfully achieved its goal of phytochemical investigation and the formulation of an Aloevera herbal gel. The investigation revealed that *Aloe barbadensis* Miller leaves are a rich source of bioactive secondary metabolites, particularly polysaccharides and phenolic compounds, which are essential for therapeutic applications.

The formulated gel developed using Carbopol 934 demonstrated excellent physicochemical properties including optimal pH (6.4) high Spreadability and stability. Most importantly the skin irritation studies confirmed that the formulation is safe non-toxic, and suitable for topical use.

In conclusion this project valid atesth at a scientifically prepared Aloevera gel can serve as a potent, natural and cost-effective alternative to synthetic topical agents. The study bridges the gap between traditional herbal wisdom and modern pharmaceutical technology providing a standardized base for future dermatological applications.

FUTURE SCOPE

1. Industrial and Commercial Use: The standardized formulation developed in this study can be scaled up for industrial production. By incorporating automated extraction and stabilization techniques, this gel can be manufactured as a base for various Over-the-Counter (OTC) herbal products.
2. Cosmetic Applications: Future research could explore the incorporation of this gel into diverse cosmetic products such as sunscreens anti-aging creams and hair care formulations leveraging its moisturizing and UV-protective properties.
3. Clinical Trials: While the patch test confirmed safety further clinical trials could be conducted to evaluate the efficacy of this specific formulation in treating chronic skin conditions like psoriasis, eczema, or diabetic foot ulcers.
4. Synergistic Formulations: The gel base can be used to incorporate other herbal extracts (e.g. Neem, Turmeric or Tulsi) to create synergistic formulations for specific Antimicrobial or wound-healing requirements.

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