



# Formulation And In Vitro Evaluation Of Herbal Anti -Pollution Face Serum Using Natural Antioxidants And Barrier Forming Polymer

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## Abstract

The present study focuses on the formulation and evaluation of a herbal face serum using natural ingredients such as Aloe vera, Green tea extract, and Sodium alginate. Herbal cosmetics are widely preferred due to their safety, effectiveness, and minimal side effects compared to synthetic products. The formulated serum was designed to provide moisturizing, antioxidant, soothing, and skin-protective effects.

The herbal extracts were subjected to phytochemical screening to identify the presence of important bioactive constituents. The tests confirmed the presence of phenolic compounds and flavonoids, which are known for their antioxidant and antimicrobial activities. The prepared serum was evaluated for various physicochemical parameters including pH, viscosity, consistency, spreadability, homogeneity, odour, washability, stability, and skin irritation test.

The evaluation results showed that the serum possessed suitable pH, smooth consistency, good spreadability, uniform appearance, pleasant odour, easy washability, and excellent stability. No signs of redness, itching, or irritation were observed during the skin irritation test, indicating that the formulation is safe for topical application. The study concludes that the prepared herbal face serum is stable, effective, and suitable for cosmetic use, with potential benefits for skin hydration and protection against environmental damage.

**KEYBOARDS:** Aloe vera, Green Tea Extract, Sodium Alginate, Antioxidant Activity, Anti Pollution Face Serum

## 1. INTRODUCTION

Skin, the largest organ of the human body, acts as a primary barrier against environmental aggressors. In recent years, rapid industrialization and urbanization have led to increased exposure to air pollutants such as particulate matter (PM), polycyclic aromatic hydrocarbons (PAHs), ozone, and heavy metals, which significantly affect skin health. These pollutants penetrate the skin either directly or through hair follicles, leading to the generation of reactive oxygen species (ROS) and oxidative stress.(1)

Oxidative stress is one of the major mechanisms responsible for pollution-induced skin damage. It leads to lipid peroxidation, protein degradation, DNA damage, and activation of inflammatory pathways, ultimately resulting in premature aging, pigmentation, acne, and loss of skin elasticity.(2) Studies have shown that prolonged exposure to environmental pollutants accelerates extrinsic aging and disrupts the natural skin barrier function.(3)

To combat these harmful effects, the use of natural antioxidants has gained considerable attention in dermatological and cosmeceutical research. Natural antioxidants such as flavonoids, phenolic compounds, vitamins, and plant extracts (e.g., green tea, turmeric, aloe vera) have the ability to neutralize ROS, thereby protecting the skin from oxidative damage .(4) These phytochemicals also exhibit anti-inflammatory, antimicrobial, and skin-repairing properties, making them ideal candidates for topical formulations.(5)

In addition to antioxidants, barrier-forming polymers play a crucial role in protecting the skin from pollutant penetration. Natural polymers such as sodium alginate, form a thin protective film over the skin surface, enhancing hydration and acting as a physical barrier against environmental contaminants.(6) Sodium alginate, a biodegradable and biocompatible polymer derived from brown seaweed, is widely used in topical drug delivery systems due to its excellent film-forming and gel-forming properties.(7)

Face serums are lightweight, fast-absorbing topical formulations that deliver active ingredients effectively into the skin. Compared to creams, serums contain higher concentrations of active constituents and are designed for targeted action. Incorporating natural antioxidants and barrier-forming polymers into a serum formulation can provide dual protection by both neutralizing free radicals and preventing pollutant deposition on the skin surface.(8)

Recent research in herbal cosmetics emphasizes the development of multifunctional formulations that combine efficacy with safety. Herbal anti-pollution serums represent a promising approach in modern skincare due to their minimal side effects, eco-friendly nature, and enhanced therapeutic potential.(9) Therefore, the present study focuses on the formulation and in-vitro evaluation of a herbal anti-pollution face serum using natural antioxidants and barrier-forming polymers to assess its protective and antioxidant efficacy.(10)

Face serum is a highly concentrated emulsion which is available in water based and oil based. Serums or defined a concentrate, contain approximately ten times more of biologically active substances than creams, therefore allows better skin problems treatment.(11) Serum is packed with a bunch of beneficiary active components and nutrients such as antioxidants, ceramides, amino acids and others. This explains why face serum always being the costliest item in a skin care set.(12) Additional value can be given to these formulations by including plant extracts with specific cosmetic effects. Particularly advantageous cosmetic emulsion preparations are obtained when antioxidants are used as active ingredients. An extract of fenugreek can be obtained by macerating the powdered seeds in methanol (80%) and filtering and concentrating it on a rotary evaporator. Extract so obtained is rich in polyphenols, galactomannans and flavonoids that have some cosmetic benefit on the skin due to their antioxidant and emollient properties.(13)

Therefore, it deals with the cosmetic problem quickly and effectiveness. Face serum is a highly concentrated emulsion which is available in water based and oil based. Serums or defined a concentrate, contain approximately ten times more of biologically active substances than creams, therefore allows better skin problems treatment.(14) Incorporating a few drops of face serum with daily skin care routine will deliver noticeable results within a month or less. This is because face serums are made of very small molecules that help it to penetrate deep into the skin quickly. Serum is packed with a bunch of beneficiary active components and nutrients such as antioxidants, ceramics, amino acids and others. This explains why face serum always being the costliest item in a skin care set. Weather it is moisturizer, anti- wrinkle or anti-aging product or skin serum, all these products should contain antioxidants, cell-communicating ingredients and skin-identical ingredients.(15)

### 1.1 TYPES OF FACIAL SERUMS(16)

1. Antioxidant Serums
2. Hydrating Serums
3. Brightening Serums
4. Anti-ageing Serums
5. Serums for Hyper-pigmentation.
6. Serums that reduce acne and fades acne scarring
7. Serums for sensitive skin
8. Serums for combination skin

### 1.2 CLASSIFICATION OF FACE SERUM(17)

#### 1.2.1 Base on Function / Skin Concern

1. Hydrating Serums
2. Brightening Serums
3. Anti - Aging Serums
4. Acne Control Serums
5. Soothing / Anti - Inflammatory Serums
6. Pigmentation / Spot Removal
7. Firming & Lifting Serums
8. Antioxidant Serum

#### 1.2.2 Base on Active Ingredients

1. Ayurveda - Based Serums
2. Botanical Extract - Based Serums
3. Fruit / Enzyme - Based Serums
4. Floral Water - Based Serums

#### 1.2.3 Based on Formulation Type

1. Oil - Based Serums
2. Gel - Based Serums
3. Emulsion Serums

### 1.3 IDEAL PROPERTIES OF FACE SERUM(18)

1. Lightweight Texture
2. High Concentration of Active Ingredients
3. Non – Comedogenic
4. Stable and Potent Formulation
5. PH Balanced
6. Sutable for Skin Type
7. Fragrance - Free or Hypoallergenic
8. Layering Compatibility
9. Clean and Safe Ingredients
10. Packaging that Protects Integrity

### 1.3.1 BENEFITS

1. Deep Skin Penetration
2. Hydration
3. Brightening
4. Anti - Aging Effects
5. Acne Control
6. Even Skin Tone
7. Improved Skin Texture
8. Calms Sensitive Skin

Aloe vera

Aloe vera gel can be used in a face serum to provide hydration, soothe irritation, and offer antioxidant benefits, making it a valuable addition to a skincare routine.(19) It can be applied directly to the face as a moisturizer or mixed with other ingredients to create a homemade serum.(20)



**FIGURE 1: Aloe vera**

## 2. Synonyms of Aloe vera

- **Scientific Name:** Aloe vera
- **Other Names:** Aloe barbadensis, Ghritkumari (Hindi), Kumara (Sanskrit), Burn plant, Miracle plant, Lily of the desert

## 3. Biological Source

Aloe Vera gel is obtained from the parenchymatous cells in the leaves of Aloe Vera plant. The gel is the mucilaginous, water-rich inner part of the leaf.(21)

## 4. Family: Liliaceae

## 5. Chemical Constituents

- Aloe Vera gel contains both active and supportive constituents

### ➤ Major Components

- Polysaccharides: Acemannan, Glucomannans
- Vitamins: Vitamin A, C, E, B12, Folic acid
- Enzymes: Amylase, Catalase, Cellulase, Lipase
- Minerals: Calcium, Magnesium, Zinc, Selenium, Sodium
- Amino Acids: 20 of the 22 required amino acids including 7 of the 8 essential ones.(22)

### ➤ Benefits of using Aloe vera gel in a face serum:

- Hydration
- Soothing and Anti-inflammatory
- Antioxidant Protection:
- Acne Treatment Skin Tone and Texture Improvement

### ➤ Skin Benefits

- Moisturizing Wound Healing Acne treatment Anti - aging Sunburn Relief(23)

## ➤ Green tea

Green Tea (*Camellia sinensis*)

### ➤ Botanical Description

Green tea is obtained from the leaves of *Camellia sinensis*, a plant belonging to the family Theaceae. It is widely cultivated in countries such as China, India, and Japan. Unlike black tea, green tea undergoes minimal processing, which helps in preserving its natural bioactive compounds. Due to its rich chemical composition, green tea has been extensively studied for its health-promoting properties.(24)



**FIGURE 2: Green Tea (*Camellia sinensis*)**

### ➤ Phytochemical Constituents

Green tea contains a variety of bioactive compounds, among which polyphenols are the most important. The major polyphenolic compounds present in green tea are catechins, including:

- Epigallocatechin gallate (EGCG)
- Epigallocatechin (EGC)
- Epicatechin gallate (ECG)
- Epicatechin (EC)

Among these, EGCG is the most abundant and biologically active compound. In addition to catechins, green tea also contains flavonoids, tannins, caffeine, and amino acids. These compounds contribute to its antioxidant and antimicrobial properties.(25)

### ➤ Pharmacological Activities

Green tea exhibits several important pharmacological activities that make it suitable for topical applications:

#### • Antioxidant Activity

Green tea is a powerful antioxidant due to the presence of catechins. These compounds neutralize free radicals and reduce oxidative stress, thereby protecting skin cells from damage. This helps in preventing premature aging, wrinkles, and other skin disorders.

#### • Antimicrobial Activity

Green tea has been reported to inhibit the growth of various microorganisms, including bacteria and fungi. This property makes it useful in preventing skin infections and acne.(26)

#### • Anti-inflammatory Activity

Green tea reduces inflammation by inhibiting the production of inflammatory mediators. This helps in soothing irritated skin and reducing redness.

#### • Photoprotective Effect

Green tea polyphenols provide protection against harmful effects of UV radiation, thereby preventing sun-induced skin damage.(27)

### ➤ Role in Topical Formulation

In herbal gel formulations, green tea acts as a key active ingredient by:

- Providing antioxidant protection
- Preventing microbial growth

- Improving skin texture and appearance
- Reducing signs of aging.(28)

#### ➤ **Combination of Medicinal Plant**

The combination of green tea (*Camellia sinensis*) and aloe vera (*Aloe barbadensis Miller*) is used to achieve a **synergistic effect**, where the combined action of both herbs is greater than their individual effects. Green tea is rich in polyphenols, especially catechins, which provide strong antioxidant and antimicrobial properties. It helps in neutralizing free radicals and protecting the skin from oxidative damage and aging. On the other hand, aloe vera is well known for its moisturizing, soothing, and wound-healing properties due to the presence of polysaccharides, vitamins, and enzymes.(29)

When combined in a single formulation, green tea enhances protection against oxidative stress and microbial infections while aloe vera improves hydration, reduce irritation, and promotes skin repair. This complementary action results in a more effective topical formulation that provides antioxidant, antimicrobial, anti-inflammatory, and healing benefits simultaneously. Therefore, the combination of these two herbs is widely used in herbal gels to improve overall skin health and therapeutic efficacy.(30)

## 6. REVIEW OF LITRETURE

Sr. No.	Author(s)	Year	Key Finding
1	Mehta et al.	2024	Concluded that combining antioxidants and polymers provides dual protection against pollutants.
2	Verma et al.	2023	Demonstrated that herbal serums enhance skin repair and reduce oxidative stress.
3	Choudhary et al.	2023	Reported that natural polymers improve stability and efficacy of topical formulations.
4	Rani et al.	2023	Showed that anti-pollution skincare reduces pigmentation and improves skin barrier function.
5	Patel et al.	2022	Studied sodium alginate and confirmed its film-forming and moisturizing properties.
6	Kumar et al.	2022	Reported that fenugreek extract exhibits strong antioxidant and anti-aging activity.
7	Zhang et al.	2022	Found that flavonoids neutralize free radicals and prevent skin damage.
8	Lee et al.	2021	Showed that green tea polyphenols protect skin from UV radiation and environmental stress.
9	Gupta & Sharma	2021	Highlighted the effectiveness of herbal cosmetics due to antioxidant

			and anti-inflammatory properties.
10	Ali et al.	2021	Reported increased ROS production in skin exposed to environmental toxins.
11	Singh et al.	2021	Evaluated herbal formulations and observed improved skin hydration and elasticity.
12	Chen et al.	2021	Demonstrated that barrier-forming polymers enhance skin protection against pollutants.
13	Sharma et al.	2020	Reported that air pollution increases oxidative stress leading to premature skin aging and pigmentation.
14	Kim et al.	2020	Found that particulate matter (PM2.5) damages the skin barrier and induces inflammation via ROS generation.
15	Wang et al.	2020	Demonstrated that antioxidants reduce pollutant-induced oxidative damage in skin cells.

## 7. AIM AND OBJECTIVE

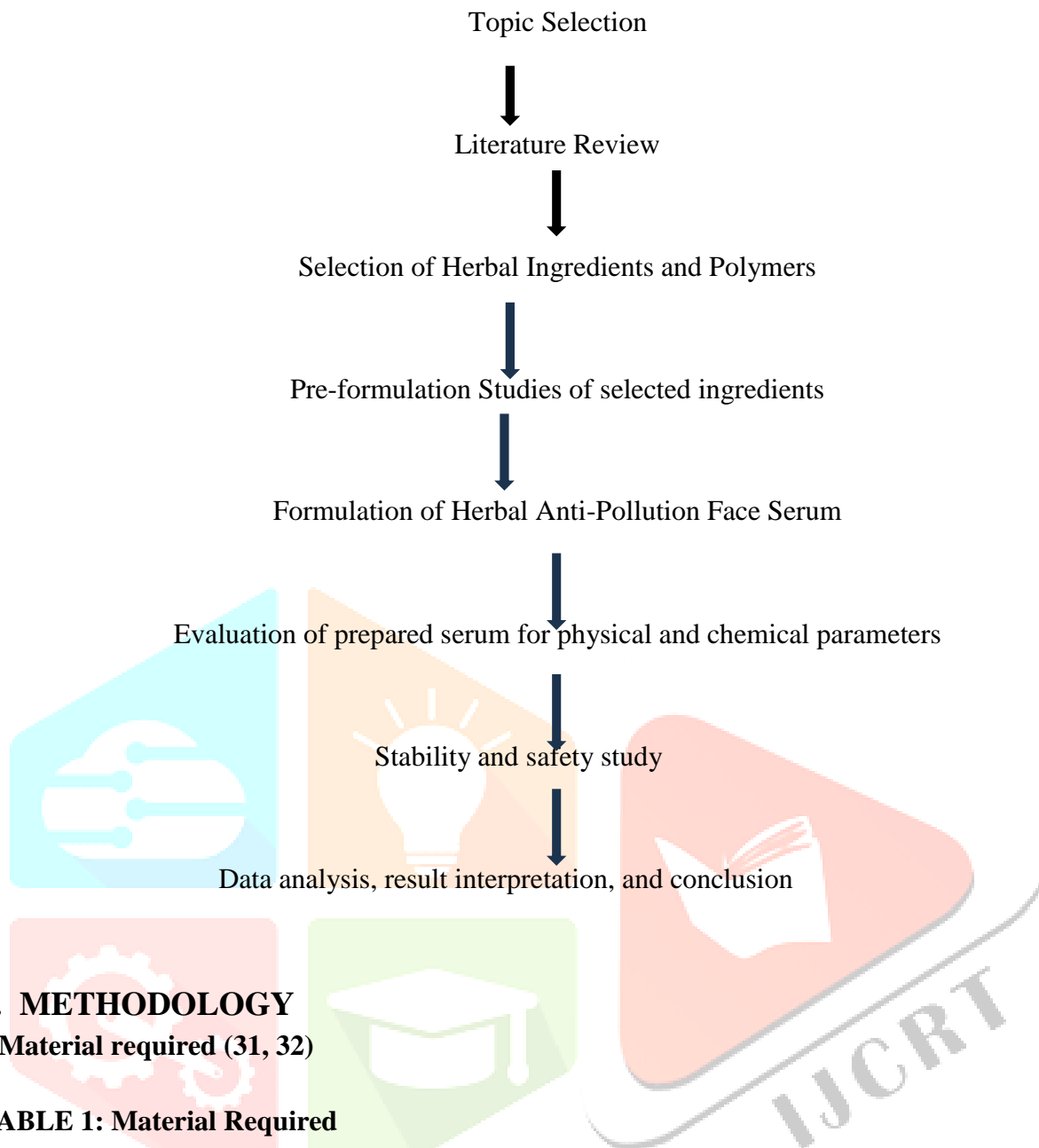
### AIM

The aim of the present study is to formulate and carry out in vitro evaluation of herbal anti-pollution face serum using natural antioxidants and barrier-forming polymers to protect the skin against pollution-induced oxidative stress and to enhance skin barrier function

### OBJECTIVE

- To select and authenticate suitable herbal ingredients rich in natural antioxidants for anti-pollution skincare application.
- To formulate a stable herbal face serum using natural antioxidants and barrier-forming polymers.
- To formulate a desirable physicochemical properties such as pH, viscosity, homogeneity and spreadability.
- To perform in vitro physicochemical evaluation including appearance, consistency, pH, and stability studies.

## 8. PLAN OF WORK



## 9. METHODOLOGY

### 1 Material required (31, 32)

**TABLE 1: Material Required**

Ingredient	Quantity	Purpose
Green tea extract ( <i>Camellia sinensis</i> )	2–3 ml	Antioxidant, antimicrobial
Aloe vera extract ( <i>Aloe barbadensis</i> Miller)	5 ml	Moisturizing, healing
Propylene glycol	2 ml	Humectant (retains moisture, improves penetration)
Methyl paraben	0.1 g	Preservative (prevents microbial growth)
Ethanol	5–10 ml	Solvent (used for extraction)
Distilled water	Up to 50 ml	Vehicle (base of gel)

## ➤ Extraction of Green Tea Extract (33–35)

### Step 1: Preparation of Drug

- Take dried green tea leaves
- Grind into coarse powder
- Coarse particles improve solvent flow

### Step 2: Imbibition (Moistening)

- Add sufficient ethanol to moisten powder
- Mix uniformly
- Keep in closed container for 2–4 hours
- Helps swelling and better extraction

### Step 3: Packing of Percolator

- Place filter paper/cotton at bottom
- Transfer moistened powder
- Pack gently (not too tight)
- Close outlet

### Step 4: Maceration

- Add ethanol to fully cover powder
- Keep for 24 hours
- Allows proper solvent penetration

### Step 5: Percolation

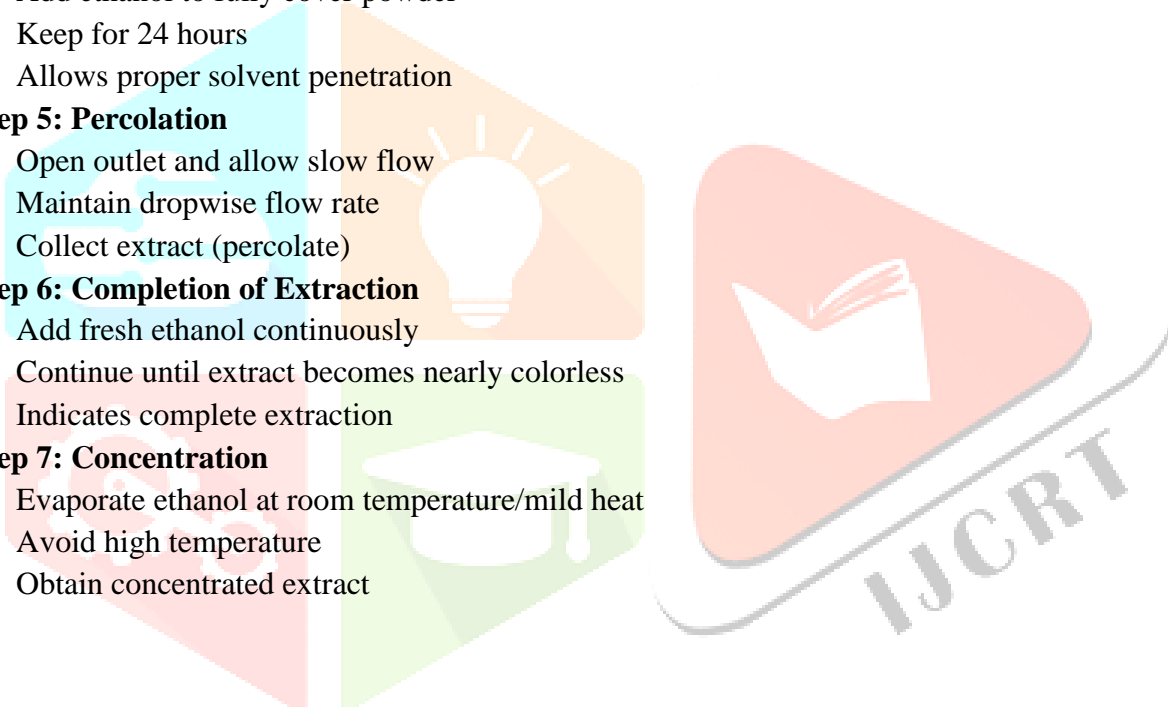
- Open outlet and allow slow flow
- Maintain dropwise flow rate
- Collect extract (percolate)

### Step 6: Completion of Extraction

- Add fresh ethanol continuously
- Continue until extract becomes nearly colorless
- Indicates complete extraction

### Step 7: Concentration

- Evaporate ethanol at room temperature/mild heat
- Avoid high temperature
- Obtain concentrated extract





**FIGURE 3: Extraction of Green Tea**

### ➤ Extraction of Aloe vera Extract (36–38)

#### Step 1: Collection and Cleaning

- Collect fresh aloe vera leaves
- Wash with distilled water

#### Step 2: Removal of Outer Layer

- Cut ends and remove spines
- Peel outer green layer
- Collect inner gel

#### Step 3: Removal of Latex

- Wash gel to remove yellow latex (aloin)
- Prevents irritation

#### Step 4: Grinding / Homogenization

- Cut gel into small pieces
- Grind using mortar and pestle
- Form uniform slurry

#### Step 5: Ethanol Extraction

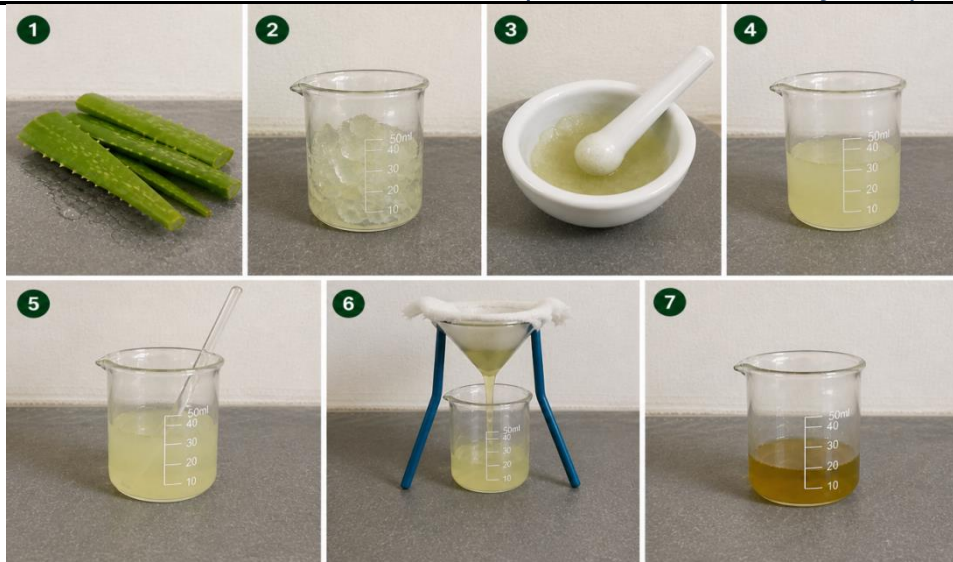
- Add ethanol in 1:1 ratio
- Mix properly
- Keep for 15–30 minutes with stirring

#### Step 6: Filtration

- Filter using muslin cloth/filter paper
- Remove fibers and impurities
- Collect clear extract

#### Step 7: Concentration

- Evaporate ethanol at room temp/mild heat
- Avoid overheating
- Obtain concentrated aloe vera extract



**FIGURE 4: Extraction of Aloe vera**

### ➤ Formulation of Herbal Face Serum

#### Step 1: Preparation of Gel Base

- Weigh required quantity of Carbopol 940 (0.5 g)
- Disperse it slowly in a small amount of distilled water
- Stir continuously to avoid lump formation
- Allow it to hydrate and swell for 30–60 minutes

#### Step 2: Addition of Humectant

- Add propylene glycol (2 ml) to the hydrated Carbopol
- Mix thoroughly to obtain a uniform mixture
- This helps in moisture retention and smooth texture

#### Step 3: Incorporation of Preservative

- Dissolve methyl paraben (0.1 g) in a small quantity of ethanol
- Add this solution to the mixture
- Stir well to ensure proper distribution

#### Step 4: Addition of Herbal Extracts

- Add green tea extract (2–3 ml)
- Add aloe vera extract (5 ml)
- Mix gently and uniformly
- These provide antioxidant, soothing, and healing effects

#### Step 5: Volume Adjustment

- Add distilled water gradually to make up the volume (up to 50 ml)
- Stir continuously to maintain uniform consistency

#### Step 6: pH Adjustment and Gel Formation

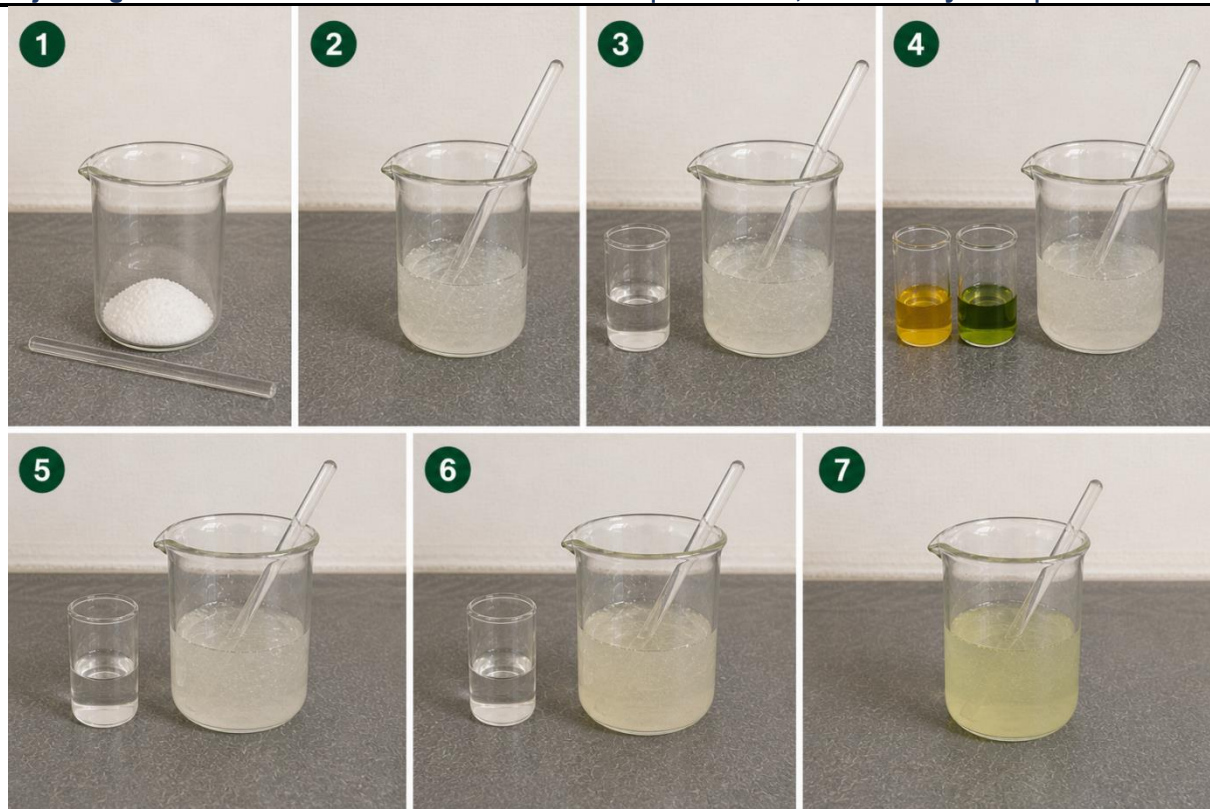
- Add triethanolamine dropwise
- Stir continuously until gel formation occurs
- Adjust pH to skin-friendly range (5.5–6.5)

#### Step 7: Final Mixing

- Mix the formulation thoroughly to ensure homogeneity
- Check for smooth texture and absence of lumps

#### Step 8: Storage

- Transfer the prepared serum into a clean, airtight container
- Store in a cool and dry place



**FIGURE 5: Formulation of Herbal Face Serum**

## 10.RESULT AND DISCUSSION

### 6.1 Phytochemical Screening of Herbal Extract

Phytochemical analysis was performed to determine the presence of important bioactive constituents in the plant extracts. Special emphasis was given to identifying **phenols and flavonoids**, as they contribute to antioxidant and antimicrobial properties.

#### 1. Test for Phenols (Ferric Chloride Test)

##### ➤ Principle:

- Phenolic compounds react with ferric chloride ( $\text{FeCl}_3$ )
- This reaction produces a colored complex such as blue, green, or violet

##### ➤ Procedure:

- Take 2 ml of plant extract in a test tube
- Add 2–3 drops of 5% ferric chloride solution
- Mix gently

##### ➤ Observation:

- Development of blue-green or dark green coloration

##### ➤ Result:

- Confirms the presence of phenolic compounds



**FIGURE 6: Test for Phenol**

## 2. Test for Flavonoids (Alkaline Reagent Test)

### ➤ Principle:

- Flavonoids react with alkaline solution (NaOH) to produce a yellow color
- The color disappears upon addition of acid (HCl)

### ➤ Procedure:

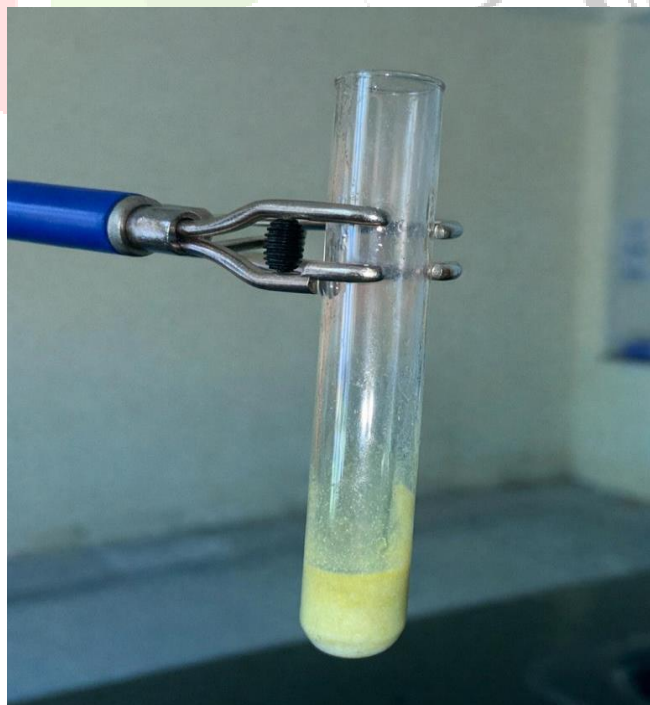
- Take 2 ml of extract
- Add a few drops of sodium hydroxide solution
- Then add dilute hydrochloric acid

### ➤ Observation:

- Yellow coloration appears and disappears after acid addition

### ➤ Result:

- Indicates the presence of flavonoids



**FIGURE 7: Test for Flavonoids**

## 6.2 Evaluation Parameters of Herbal face Serum

The prepared herbal gel was evaluated to assess its **quality, stability, effectiveness, and safety** for topical use. The following parameters were examined:

### 6.2.1 pH

➤ **Description:**

- Indicates the acidic or basic nature of the serum
- Important for skin compatibility

➤ **Procedure:**

- Measured using a pH meter or pH paper

➤ **Steps:**

- Take 1 g of gel
- Dissolve in 10 ml of distilled water
- Dip the electrode or pH strip
- Record the reading

➤ **Ideal Result:**

- pH should be between **5.5–7**, suitable for skin application

### 6.2.2 Viscosity

➤ **Description:**

- Refers to thickness and resistance to flow
- Affects application and stability

➤ **Procedure:**

- Determined using a viscometer

➤ **Steps:**

- Place gel sample in the viscometer
- Select suitable spindle and speed
- Record the viscosity value

➤ **Ideal Result:**

- Moderate viscosity (neither too thick nor too fluid)

### 6.2.3 Consistency

➤ **Description:**

- Indicates the texture and feel of the serum

➤ **Procedure:**

- Checked manually and visually

➤ **Steps:**

- Take a small amount of serum
- Rub between fingers
- Observe texture

➤ **Ideal Result:**

- Smooth, uniform, and non-sticky consistency

### 6.2.4 Spreadability

➤ **Description:**

- Determines ease of spreading on skin

➤ **Procedure:**

- Evaluated using glass slide method

➤ **Steps:**

- Place gel between two glass slides
- Apply weight on the upper slide
- Measure spreading time

➤ **Ideal Result:**

- Should spread easily with minimal effort

### 6.2.5 Homogeneity

➤ **Description:**

- Indicates uniform distribution of ingredients

➤ **Procedure:**

- Assessed by visual inspection

➤ **Steps:**

- Observe gel carefully
- Check for lumps or particles

➤ **Ideal Result:**

- Uniform and lump-free appearance

### 6.2.6 Odour

➤ **Description:**

- Refers to the smell of the formulation

➤ **Procedure:**

- Evaluated by sensory method

➤ **Steps:**

- Take a small amount
- Smell gently

➤ **Ideal Result:**

- Pleasant or characteristic odour without foul smell

### 6.2.7 Washability

➤ **Description:**

- Indicates ease of removal from skin

➤ **Procedure:**

- Tested with water

➤ **Steps:**

- Apply gel on skin
- Wash with water
- Observe removal

➤ **Ideal Result:**

- Easily washable without leaving residue

### 6.2.8 Stability

#### ➤ Description:

- Measures ability to maintain properties over time

#### ➤ Procedure:

- Stored under different conditions

#### ➤ Steps:

- Keep samples at room and cool temperatures
- Observe periodically
- Check changes in color, pH, and consistency

#### ➤ Ideal Result:

- No significant changes should occur

### 6.2.9 Skin Irritation Test

#### ➤ Description:

- Ensures safety for topical application

#### ➤ Procedure:

- Performed on skin

#### ➤ Steps:

- Apply small amount on forearm
- Leave for 24 hours
- Observe for any reaction

#### ➤ Ideal Result:

- No redness, itching, or irritation.

### 6.2.10 OBSERVATION

**TABLE 2 : Obserbation Table Of Evaluation Parameter And Physiochemical Screening**

Sr. no.	Test / Parameter	Observation	Result
1	Phytochemical Screening – Phenol Test (Ferric Chloride Test)	Blue-green / dark green color observed	Presence of phenolic compounds confirmed
2	Phytochemical Screening – Flavonoid Test (Alkaline Reagent Test)	Yellow color appears and disappears on adding acid	Presence of flavonoids confirmed
3	Physical Appearance	<ul style="list-style-type: none"> <li>• Colour: Light to dark green</li> <li>• Odour: Pleasant / characteristic</li> <li>• Texture: Smooth and uniform</li> </ul>	Acceptable
4	pH	5.3 (skin compatible range)	Suitable for topical application
5	Viscosity	Moderate viscosity (not too thick or runny)	Good spreadability and stability
6	Skin Irritation Test	No redness, itching, or irritation observed	Safe for skin
7	Stability	No change in color,	Stable formulation

		pH, or consistency over time	
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## 7. CONCLUSION

The present study was successfully carried out with the aim of formulating and evaluating a herbal face serum using natural ingredients such as green tea extract (*Camellia sinensis*) and aloe vera extract (*Aloe barbadensis Miller*). The growing demand for herbal and natural cosmetic products has encouraged the development of formulations that are safe, effective, and free from harmful synthetic chemicals. In this context, the selected plant-based ingredients were chosen due to their well-known therapeutic and cosmetic benefits, particularly their antioxidant, antimicrobial, moisturizing, and soothing properties.

Phytochemical screening of the prepared extracts confirmed the presence of important bioactive constituents, especially phenolic compounds and flavonoids. These compounds are widely recognized for their strong antioxidant activity, which plays a significant role in neutralizing free radicals generated due to environmental pollutants and UV exposure. Their antimicrobial properties also contribute to maintaining healthy skin by preventing microbial growth.

The formulated herbal face serum was further evaluated for various physicochemical parameters to ensure its quality, stability, and suitability for topical application. The pH of the formulation was found to be within the acceptable range of skin pH, indicating that it is unlikely to cause irritation or discomfort upon application. The viscosity of the serum was appropriate, ensuring ease of application without being too thick or too runny. The formulation also demonstrated good consistency, smooth texture, and excellent spreadability, allowing uniform distribution on the skin surface.

Other important parameters such as washability and odour were also satisfactory. The serum was easily washable without leaving any greasy residue, which enhances user acceptability. The odour of the formulation was pleasant and characteristic of the herbal ingredients, making it more appealing for regular use. Stability studies carried out under different storage conditions revealed that the formulation remained stable over time, with no significant changes observed in color, pH, or consistency. Furthermore, the skin irritation test confirmed that the formulation is safe for topical use. No signs of redness, itching, or irritation were observed after application, suggesting that the serum is gentle and suitable for different skin types. This highlights the advantage of using natural ingredients, which are generally well.

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