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# Formulation and Evaluation of Herbal Sunscreen

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Abstract: The harmful effects of ultraviolet (UV) radiation, including photoaging, erythema, and increased risk of skin cancer, have intensified the demand for effective sun protection. However, the long-term use of synthetic sunscreens has raised concerns due to potential adverse effects such as skin irritation, allergic reactions, and environmental toxicity. In response, the present study focuses on the formulation and evaluation of a herbal sunscreen incorporating natural ingredients known for their photoprotective, antioxidant, and skin-nourishing properties. The formulation was prepared using aloe vera gel, green tea extract, coconut oil, beeswax, zinc oxide, lavender essential oil, and vitamin E. Aloe vera and green tea provide antioxidant and anti-inflammatory benefits, while zinc oxide acts as a physical UV filter. The sunscreen cream was developed using a simple emulsification method and evaluated for physicochemical parameters including appearance, pH, spreadability, washability, stability, and sun protection factor (SPF) using an in vitro spectrophotometric method. The results demonstrated that the formulation possessed suitable consistency, skin-compatible pH (6.0-7.0), good spreadability, and a moderate SPF value, indicative of its potential effectiveness in UV protection. Stability studies conducted over a one-week period at room temperature showed no phase separation or degradation. Additionally, a patch test confirmed the absence of skin irritation on human volunteers. In conclusion, the herbal sunscreen formulation was found to be stable, safe, and effective, offering a promising natural alternative to synthetic sunscreens. This research supports the potential application of herbal ingredients in the development of eco-friendly and skin-compatible sun care products.

Keywords: effects of ultraviolet

## I. INTRODUCTION

The increasing awareness about the harmful effects of synthetic chemicals used in cosmetic products has led to a growing interest in herbal formulations. Sunscreens, which are essential for protecting the skin from the damaging effects of ultraviolet (UV) radiation, are no exception. Continuous exposure to UV rays can result in sunburn, premature aging, hyperpigmentation, and even skin cancer. Hence, the use of sunscreens has become an integral part of daily skincare routines.

Conventional sunscreens often contain chemical agents like oxybenzone, avobenzone, and octinoxate, which, although effective, may cause allergic reactions, skin irritation, or hormonal disturbances in some users. As a result, the demand for herbal sunscreens has surged due to their natural origin, better skin compatibility, and lower risk of side effects. Herbal sunscreens are formulated using plant-based ingredients known for their UV- protective, antioxidant, anti-inflammatory, and skin-soothing properties. Natural substances such as aloe vera, green tea, turmeric, cucumber, and sandalwood have demonstrated photoprotective effects and are widely used in traditional medicine for skincare.

This project aims to formulate a sunscreen using selected herbal ingredients and evaluate its physicochemical properties, sun protection factor (SPF), spreadability, pH, and stability. The goal is to develop a safe, effective, and eco-friendly alternative to commercial sunscreens, contributing to the advancement of herbal cosmetic science.

#### Need for herbal sunscreen

With the increasing awareness of the harmful effects of ultraviolet (UV) radiation, the use of sunscreens has become a vital part of skincare routines. Exposure to UV rays, especially UVA and UVB, can cause sunburn, photoaging, hyperpigmentation, DNA damage, and even skin cancer. As a result, the global demand for effective and safe sunscreens is steadily rising.

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However, many commercial sunscreens contain synthetic chemicals like oxybenzone, avobenzone, and octinoxate. These compounds have been associated with various side effects, including:

- Skin irritation and allergies
- Hormonal disruptions
- Coral reef bleaching and environmental hazards
- Phototoxic reactions in sensitive individuals

Due to these concerns, there is a growing preference for herbal and natural alternatives that are safe, biodegradable, and skin-friendly. Herbal sunscreens are formulated using plant-based ingredients that offer multiple benefits, such as:

- UV protection through natural filters like zinc oxide
- Antioxidant activity that neutralizes free radicals
- Soothing and healing properties that calm inflamed or sun-exposed skin
- Moisturizing and nourishing effects that maintain skin health

Herbs like aloe vera, green tea, coconut oil, and vitamin E not only provide sun protection but also enhance the overall health of the skin. These ingredients are generally well-tolerated and suitable for long-term use without causing harm to the skin or the environment.

Therefore, there is a clear and significant need for herbal sunscreens as a safer, more sustainable, and holistic approach to sun protection. This project aims to address that need by developing an effective herbal sunscreen formulation using carefully selected natural ingredients.

### Literature review

Herbal cosmetics are increasingly popular due to their minimal side effects and skin- friendly properties. In recent years, research has focused on the use of natural substances to develop sunscreens that protect the skin from harmful ultraviolet (UV) radiation while nourishing it with herbal ingredients. Several studies have reported the photoprotective and antioxidant potential of herbs, making them ideal candidates for sunscreen formulations.

## Aloe Vera (Aloe barbadensis)

Aloe vera has been extensively studied for its soothing, anti-inflammatory, and healing properties. It contains vitamins (A, C, E), polysaccharides, and enzymes that help in skin hydration and regeneration. Studies suggest that aloe vera can offer mild UV protection and enhance the effectiveness of other sunscreen agents.



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## **Distilled Water**

Distilled water is used as a solvent and base for most cosmetic formulations. It ensures purity and helps in blending water-soluble ingredients while maintaining the formulation's consistency.

### Green Tea Extract (Camellia sinensis)

Green tea is rich in polyphenols, especially catechins, which possess strong antioxidant and photoprotective properties. Research shows that green tea extracts can reduce UVB-induced inflammation and prevent skin damage. It also helps neutralize free radicals generated by UV exposure.



### Coconut Oil (Cocos nucifera)

Coconut oil has been traditionally used for skin care due to its moisturizing and antimicrobial properties. It provides a natural SPF value ranging from 4 to 6. Additionally, its fatty acid content helps protect the skin barrier and retain moisture.



#### Beeswax

Beeswax is used in cosmetic formulations to improve consistency and act as a thickening agent. It forms a protective layer on the skin, preventing moisture loss and enhancing the retention of active ingredients. Though not a UV blocker, it contributes to the stability and texture of the sunscreen.

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### Zinc Oxide

Zinc oxide is a well-known physical sunscreen agent that reflects and scatters both UVA and UVB rays. It is noncomedogenic and safe for sensitive skin. It is widely used in baby products, creams, and sunblocks due to its broadspectrum UV protection.



## Lavender Essential Oil (Lavandula angustifolia)

Lavender oil has antimicrobial, antioxidant, and anti-inflammatory properties. Though it is not a primary UV blocker, it aids in soothing sun-exposed skin and enhances the overall appeal of the formulation with its pleasant fragrance.

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### Vitamin E (Tocopherol)

Vitamin E is a powerful antioxidant that helps in protecting the skin from oxidative stress caused by UV radiation. It also assists in improving skin texture and reducing signs of aging.



## **Formulation Methodology**

The herbal sunscreen was formulated using a combination of oil phase and aqueous phase ingredients to form a stable emulsion. The process involved accurate weighing, controlled heating, and thorough mixing to ensure a uniform, consistent, and effective product.

## **Materials Required:-**

- Aloe Vera Gel ٠
- Green Tea Extract Coconut Oil •
- Beeswax
- Zinc Oxide •
- Lavender Essential Oil •
- Vitamin E •

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- (Tocopherol)
  - Distilled Water

Equipments required:-

- Beakers (for oil and aqueous phases)
- Magnetic Stirrer or Homogenizer
- Thermometer
- pH Meter
- Spatula
- Sterile Containers (for storage)

## **Step-by-Step Formulation Process:-**

1) Preparation of Aqueous Phase

- Combine distilled water and aloe vera gel in a beaker. Add green tea extract to the mixture.
- Heat the mixture to approximately 70°C with continuous stirring until a uniform solution is obtained.

## 2) Preparation of Oil Phase

- Melt beeswax and coconut oil together in a separate beaker by heating to 70°C. Incorporate zinc oxide into the melted oils, ensuring even dispersion.
- Add vitamin E and lavender essential oil to the mixture after removing from heat to prevent degradation.

## 3) Emulsification

• Slowly add the oil phase to the aqueous phase while continuously stirring at 70°C. Continue stirring for 15-20 minutes to form a stable emulsion.

## 4) Cooling and Finalization

- Allow the emulsion to cool to room temperature with gentle stirring. Add the natural preservative once the mixture is below 40°C.
- Adjust the pH to 5.5-6.5 using citric acid or sodium hydroxide solution if necessary.
- Transfer the final product into sterile containers and label appropri ately.

## **Evaluation Parameters**

• After the successful formulation of the herbal sunscreen, it is essential to evaluate its physicochemical, functional, and stability characteristics to ensure safety, efficacy, and user acceptability. The following parameters were used to evaluate the prepared formulation:

## 1) Physical Appearance

- Objective: To observe color, texture, and consistency. Method: Visual examination.
- Result Criteria: Smooth, uniform cream with a pleasant appearance and no phase separation.

## 2) pH Measurement

- Objective: To determine the compatibility of the sunscreen with skin (ideal pH ~5.5–6.5).
- Method: pH meter was used to test a 1% w/v dispersion of the sunscreen in distilled water.
- Result Criteria: Should be within the safe range for topical application.



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## 3) Spreadability

- Objective: To assess how easily the product spreads on the skin.
- Method: A fixed amount of formulation was placed between two glass slides and a specific weight applied. The diameter of the spread was measured.
- Result Criteria: Good spreadability ensures ease of application and consumer acceptability.

### 4) Viscosity

- Objective: To determine the thickness and flow characteristics of the cream. Method: Measured using a Brookfield viscometer.
- Result Criteria: Moderate viscosity ensures easy application without being too runny or too thick.

## 5) Washability

- Objective: To check whether the formulation can be easily washed off. Method: Applied on skin and rinsed with water.
- Result Criteria: Should be washable yet resistant enough to remain effective for a reasonable duration.

### 6) Sun Protection Factor (SPF) Determination

- Objective: To estimate the SPF value of the formulation.
- Method: UV spectrophotometric method using Mansur's equation. Absorbance was measured at wavelengths ranging from 290–320 nm.
- Result Criteria: SPF value  $\geq 15$  is desirable for moderate protection.

### 7) Stability Study

- Objective: To determine the shelf-life and physical stability of the formulation.
- Method: The formulation was stored at different temperatures (room temp, refrigeration, and elevated temp) for 30 days. Observations were made for:
- Phase separation, color change, odor, consistency
- Result Criteria: No major changes in appearance or texture over the test period.

## 8) Irritancy Test (Patch Test)

- Objective: To evaluate the safety of the formulation on human skin.
- Method: A small amount of sunscreen was applied to a patch of skin (usually the forearm or behind the ear) and monitored for 24 hours.
- Result Criteria: No redness, itching, or irritation should occur.

#### Results

• The prepared herbal sunscreen formulation was evaluated using various physicochemical and functional parameters. The results obtained are discussed below:

## 1) Physical Appearance

- Result: The formulation appeared as a smooth, light cream with a pleasant herbal fragrance. No signs of phase separation or granularity were observed.
- Discussion: The even texture and homogeneity indicate successful emulsification and good formulation stability.



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## 2) pH Measurement

- Result: The pH was found to be  $6.1 \pm 0.2$ .
- Discussion: This pH lies within the ideal range for topical application and is compatible with the skin's natural pH, making it safe for regular use.

## 3) Spreadability

- Result: The spreadability was good, with uniform distribution over the skin surface and no clumping.
- Discussion: The inclusion of coconut oil and aloe vera contributed to enhanced spreadability, which increases user compliance and ease of application.

## 4) Viscosity

- Result: The viscosity was found to be suitable, providing a creamy consistency without being too thick or runny.
- Discussion: Beeswax and zinc oxide helped maintain a stable viscosity. A good balance of viscosity ensures better skin retention and application comfort.

## 5) Sun Protection Factor (SPF)

- Result: The SPF value was calculated as  $17.6 \pm 1.3$  using the UV spectrophotometric method.
- Discussion: The SPF value suggests moderate sun protection, suitable for daily use. Zinc oxide and antioxidant-rich herbs such as green tea and vitamin E contributed significantly to the UV protective effects.

## 6) Washability

- Result: The formulation was easily washable with water while offering reasonable water resistance during wear.
- Discussion: The cream was neither too greasy nor too adherent, indicating good consumer-friendly behavior.

## 7) Stability Study

- Result: The formulation remained physically stable over 30 days at room temperature, refrigeration, and elevated temperature (40°C). No phase separation, discoloration, or odor change was noted.
- Discussion: The stable formulation confirms its shelf life and suitability for commercial application, at least over short to medium duration storage.

## 8) Irritancy Test

- Result: No signs of redness, itching, or irritation were observed during the patch test on human volunteers.
- Discussion: The formulation is dermatologically safe and suitable for sensitive skin types, supporting its herbal, gentle nature.

## **II. CONCLUSION**

The present study aimed to formulate and evaluate a herbal sunscreen using natural ingredients with known photoprotective, antioxidant, and skin-nourishing properties. The formulation containing zinc oxide, aloe vera, green tea extract, coconut oil, beeswax, lavender essential oil, and vitamin E was successfully prepared and tested for various parameters.

The results of evaluation showed:

- Pleasant physical appearance and smooth texture Skin-compatible pH
- Good spreadability and washability Acceptable viscosity and stability
- Moderate SPF value  $(17.6 \pm 1.3)$  No skin irritation on application

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These findings support the conclusion that herbal sunscreens can be a safe, effective, and eco-friendly alternative to chemical sunscreens. The product provides broad- spectrum protection while nourishing and soothing the skin, making it ideal for regular use.

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