

# FORMULATION AND EVALUATION OF HERBAL SUNSCREEN CREAM CONTAINING NATURAL PHOTOPROTECTIVE AGENTS

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## Abstract

Exposure to ultraviolet (UV) radiation is one of the major causes of skin damage, leading to conditions such as erythema, premature aging, hyperpigmentation, and skin cancer. Sunscreens are widely used as protective agents; however, synthetic sunscreen chemicals may cause skin irritation, allergic reactions, and environmental concerns. Consequently, herbal sunscreen formulations have gained significant attention due to their safety, antioxidant activity, and skin compatibility [1].

The present study aimed to formulate and evaluate herbal sunscreen creams using natural ingredients including Aloe vera, Coconut oil, Vitamin E, and Rose water. Four formulations (F1–F4) were prepared using an oil-in-water emulsion method and evaluated for physicochemical properties such as colour, odour, consistency, pH, spreadability, viscosity, washability, irritancy, phase separation, stability, and in-vitro Sun Protection Factor (SPF) [2].

All formulations showed acceptable physical characteristics and good cosmetic properties. Among the formulations, F3 containing Vitamin E demonstrated superior performance with the highest spreadability ( $6.7 \pm 0.25$  g·cm/sec), optimum viscosity ( $13,900 \pm 195$  cPs), and highest SPF value ( $19.1 \pm 0.8$ ). Stability studies indicated that the formulation remained stable without phase separation or significant changes in colour and consistency.

The results indicate that herbal ingredients can be effectively incorporated into sunscreen formulations to provide natural photoprotection and improved skin compatibility.

**Keywords:** Herbal sunscreen, Aloe vera, Vitamin E, Coconut oil, Photoprotection, Sun protection factor

## 1. Introduction

Human skin serves as a protective barrier against environmental stressors such as ultraviolet radiation, pollutants, microorganisms, and chemical agents. Among these factors, UV radiation is considered one of the major causes of dermatological disorders and skin damage [1].

Ultraviolet radiation is divided into three categories based on wavelength: UVA (320–400 nm), UVB (290–320 nm), and UVC (200–290 nm). UVC radiation is generally absorbed by the ozone layer, while UVA and UVB penetrate the Earth's surface and affect the skin. UVB radiation is mainly responsible for erythema and sunburn, whereas UVA penetrates deeper into the dermis and contributes to premature aging and DNA damage [3].

Sunscreen formulations are widely used to protect the skin by absorbing or reflecting harmful UV radiation. Conventional sunscreens contain chemical UV filters such as oxybenzone, avobenzone, and octyl methoxycinnamate, along with inorganic filters such as titanium dioxide and zinc oxide [4]. Although these agents provide effective protection against UV radiation, their long-term use has raised concerns regarding skin irritation, allergic reactions, and environmental toxicity.

In recent years, herbal and natural sunscreens have gained increasing attention due to their safety and additional therapeutic benefits. Herbal ingredients contain antioxidants, flavonoids, polyphenols, and vitamins that help protect the skin from oxidative damage caused by UV radiation [5].

Several plant-derived ingredients have been reported to possess photoprotective activity. Aloe vera exhibits anti-inflammatory, moisturizing, and antioxidant properties. Coconut oil acts as an emollient and protective barrier that reduces transepidermal water loss. Vitamin E ( $\alpha$ -tocopherol) is a potent antioxidant that prevents lipid peroxidation and protects skin cells from UV-induced oxidative damage. Rose water provides soothing and cooling effects that enhance skin comfort and cosmetic acceptability [6].

Cream formulations are commonly preferred for topical applications because they provide better spreadability, uniform distribution of active ingredients, and improved cosmetic properties. Therefore, the present study was undertaken to formulate and evaluate herbal sunscreen creams using selected natural ingredients and to determine their physicochemical characteristics and sun protection factor.

## 2. Materials and Methods

### 2.1 Materials

Aloe vera gel, Coconut oil, Vitamin E capsules, and Rose water were used as herbal active ingredients. Other excipients including beeswax, stearic acid, cetyl alcohol, stearyl alcohol, gelatin, and Tween 80 were used as emulsifying and stabilizing agents. All materials were obtained from pharmaceutical grade sources.

### 2.2 Formulation of Herbal Sunscreen Cream

Four different formulations (F1–F4) were prepared using an oil-in-water emulsion technique. The oil phase consisting of beeswax, stearic acid, cetyl alcohol, and stearyl alcohol was heated to approximately 70°C. The aqueous phase containing gelatin, Tween 80, and herbal ingredients was heated separately to the same temperature.

The aqueous phase was gradually added to the oil phase with continuous stirring until a homogeneous cream was formed. The formulation was then allowed to cool with constant stirring to obtain a stable emulsion [7].

### 2.3 Table-1: Composition of Formulations

INGREDIENTS	F1	F2	F3	F4
Aloe vera	2	–	–	–
Coconut oil (gm)	–	2	–	–
Vitamin E (ml)	–	–	2	–
Rose water (ml)	–	–	–	2
Bees wax (gm)	3	3	3	3
Stearic acid (ml)	8	8	8	8
Cetyl alcohol	1	1	1	1
Stearyl alcohol (ml)	1	1	1	1
Gelatin (ml)	4	4	4	4
Tween 80 (ml)	1	1	1	1
Total (gm)	20	20	20	20

### **3. Evaluation of Herbal Sunscreen Cream**

#### **3.1 Physical Evaluation**

The prepared creams were visually examined for colour, odour, consistency, and homogeneity.

#### **3.2 pH Determination**

The pH of the cream was measured using a digital pH meter after dispersing the sample in distilled water.

#### **3.3 Spreadability**

Spreadability was determined using the slide method, which evaluates the ease with which the cream spreads over the skin surface.

#### **3.4 Washability Test**

Washability was evaluated by applying a small quantity of cream on the skin and washing it with tap water.

#### **3.5 Irritancy Test**

The irritancy test was performed by applying the cream on the dorsal surface of the hand and observing the area for redness, irritation, or edema for 24 hours.

#### **3.6 Phase Separation**

Formulations were stored at room temperature and examined for phase separation.

#### **3.7 Viscosity**

Viscosity was determined using a Brookfield viscometer.

#### **3.8 Stability Study**

Stability studies were conducted by storing the formulations at room temperature and elevated temperature for one month [8].

#### **3.9 Determination of Sun Protection Factor**

SPF was determined using UV spectrophotometric analysis based on the Mansur equation by measuring absorbance between 290–320 nm [9].

#### 4. Results and Discussion

The various quality control parameters Like Physical Appearance/Visual Inspection, PH, Irritancy, Washability, Viscosity, After Feel Phase Separation, Spreadability, Greasiness, StabilityTest. All parameter gives favourable result. The result obtained on present study shows that the active ingredients of these drugs when incorporated in Herbal cream gives more stable products with good aesthetic appeal.

- 1) **Evaluation test:** The Formulation prepared was evaluated for the Colour, Odour and Consistency. The Colour of the cream was observed by visual examination which is faint green in Colour. The Odour of cream was found to be pleasant. The State was cream was examined visually. The cream was semisolid in nature. The formulation was examined by rubbing cream on hand manually. The cream having smooth Consistency. Results are listed in Table2.

**Table 2. physical evaluation test**

Sr. No.	Parameters	F1 (Aloe vera)	F2 (Coconut oil)	F3 (Vitamin E)	F4 (Rose water)
1	Colour	Faint green	White	Pale yellow	Light pink
2	Odour	Pleasant	Characteristic coconut	Pleasant	Pleasant rose odour
3	Consistency	Smooth	Smooth	Smooth	Smooth
4	State	Semisolid	Semisolid	Semisolid	Semisolid

#### **Washabilitytest:**

Formulation F1 was found to not be washable, indicating it could not be removed with effort. Formulations F2 and F3 were easily washable, suggesting better user convenience and less likelihood of residue on the skin. This characteristic is important for daily-use products to ensure cleanliness and comfort. Results are listed in Table3.

**Table 3. washability test.**

Sr.no	Formulation	Washability
1	F1	Not easily washable
2	F2	Moderately washable
3	F3	Easily washable
4	F4	Easily washable

#### **Irritancy test.**

Herbal Cream formulation was evaluated for the non-irritancy test. Preparation shown no redness, Edema, inflammation and irritancy. Observation of the state was done for 24 h. Results were shown in Table4.

**Table 4. Irritancy test**

Sr.no	Formulation	Irritancy effect	Erythema	Edema
1	F1	Non-irritant	Absent	Absent
2	F2	Slightly irritant	Absent	Absent
3	F3	Non-irritant	Absent	Absent
4	F4	Non-irritant	Absent	Absent

**PH test:**

The pH balance of the product is important as it affects skin and surface on which there are used. The pH of our Formulated face cream falls with the ideal pH range of the cream. this ensure that the cream maintain the skin natural pH. The results were shown in Table 5.

**Table 5. pH test**

Sr.no	Formulation	PH
1	F1	6.4 ± 0.05
2	F2	6.3 ± 0.04
3	F3	6.6 ± 0.03
4	F4	6.5 ± 0.06

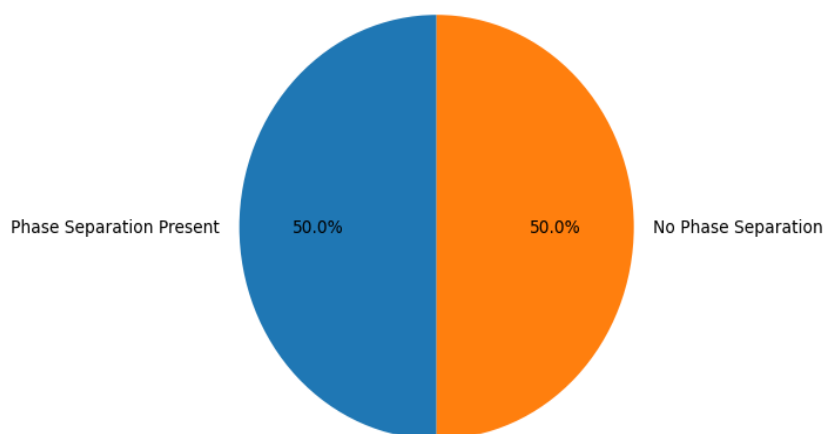
**Phase separation test:**

The prepared cream was transferred in a suitable wide mouth container. Set aside for storage the oil phase and aqueous phase separation were visualizing after 24h. F1 and F2 exhibit phase separation and F3 does not exhibit any type of phase separation. The results were shown in Table6.

**Table 6. phase separation test**

Sr.no	Formulation	Phase separation
1	F1	Present
2	F2	Present
3	F3	Absent
4	F4	Absent

Phase Separation Profile of Herbal Sunscreen Formulations

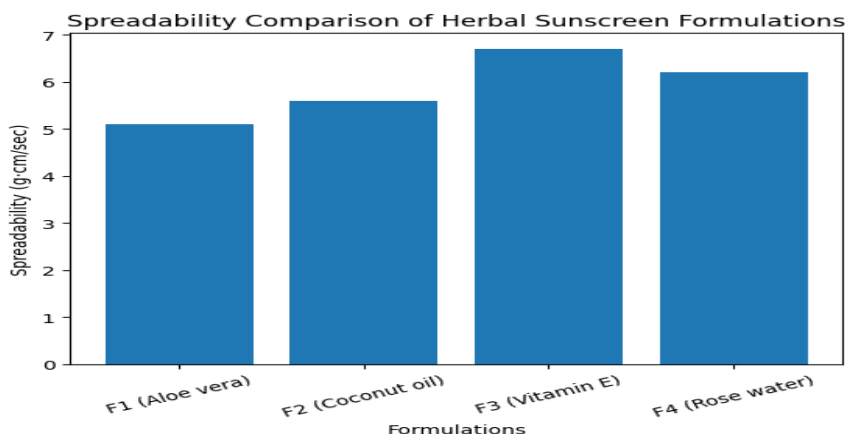


**Spreadability test.**

The spreadability result show that the F3 has the good spreadability among the formulation, making it easier to apply and more effective in covering larger areas with less product. the result show in table 7.

**Table 7. Spreadability test.**

Sr.no	Formulation	Spreadability test (g·cm/sec, Mean ± SD)
1	F1	5.1 ± 0.22
2	F2	5.6 ± 0.20
3	F3	6.7 ± 0.25
4	F4	6.2 ± 0.18



**Inference:**

The highest spreadability was observed for formulation F3, indicating better application and uniform skin coverage.

**Stability test.**

Formulation was stored at room temperature and 25C temperature for a month and observed for physical stability like colour, consistency. There is no separation occurs at both temperature so it is found to be stable. Results were shown in table 8.

**Table 8. stability test**

Formulation batches	Parameters	Temperature	Room temperature
F1	Colour, consistency	Stable	Stable
F2	Colour, consistency	Stable	Stable

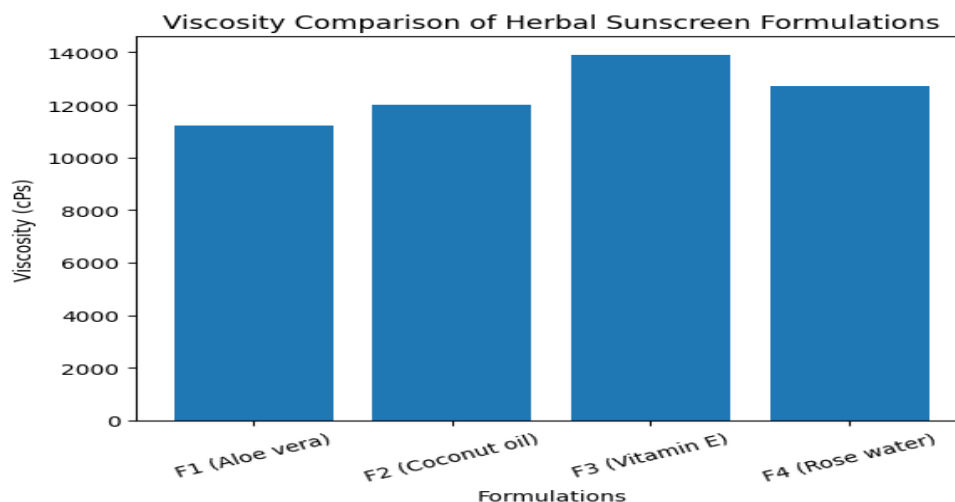
F3	Colour, consistency	Stable	Stable
F4	Colour, consistency	Stable	Stable

**VISCOSITY:**

The Brookfield viscometer was used to test viscosity, with the proper number of spindle selected (No. 4). A 50 ml beaker was used to hold 50 g of preparation until the spindle groove was dipped and the rpm was set at 100 rotations per minute, the results are presented in table 6.

**Table 9: Viscosity of different formulations**

Formulation code	Viscosity (cPs, Mean ± SD)
F1	11,200 ± 180
F2	12,000 ± 210
F3	13,900 ± 195
F4	12,700 ± 205



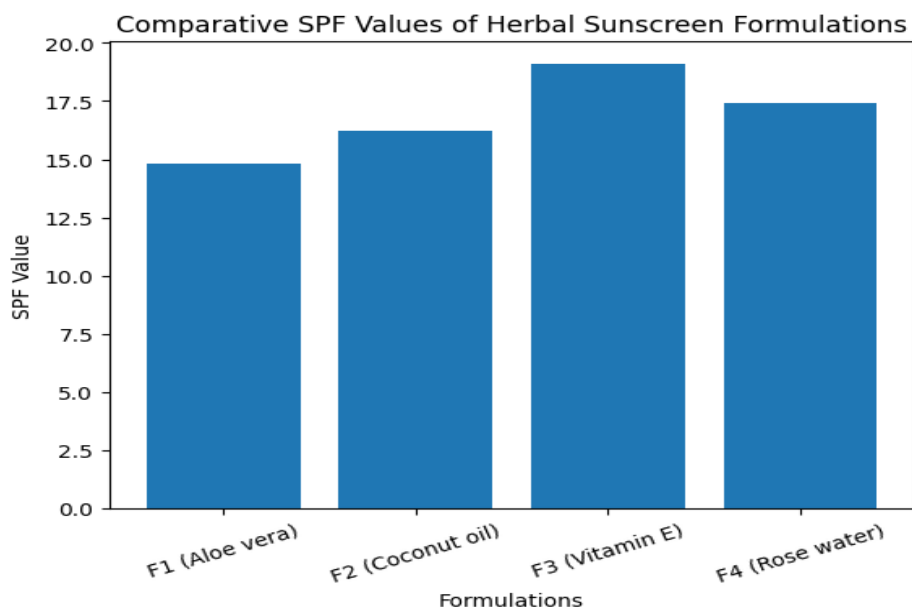
**Inference:** Formulation F3 showed optimum viscosity, contributing to better stability and cosmetic acceptability.

**IN VITRO SUN PROTECTION FACTOR EVALUATION:**

**Table 10.SPF determination**

Formulation	SPF Values
F1	14.8 ± 0.6
F2	16.2 ± 0.7
F3	19.1 ± 0.8
F4	17.4 ± 0.5

Data as presented as mean± standard deviation (n=3)



### Additional Evaluation Parameters for Herbal Sunscreen Cream

#### 1. In Vitro UV Absorbance Profile

**Description:**

The UV absorbance of the cream formulation is measured using a UV–Visible spectrophotometer in the wavelength range of **290–400 nm** (UVB & UVA region). Higher absorbance indicates better UV-protective ability.

**Table:11 UV absorbance**

Formulation	UV Absorbance at $\lambda_{max}$ (Mean $\pm$ SD)
F1	1.21 $\pm$ 0.05
F2	1.38 $\pm$ 0.04
F3	1.62 $\pm$ 0.06
F4	1.45 $\pm$ 0.05

✓F3 shows highest UV absorbance

**Inference:** Formulation F3 exhibited the highest SPF value, indicating superior UV protection compared to other formulations.

#### 2. Sun Protection Factor (SPF Retention Study)

**Description:**

SPF retention was evaluated after storing the formulation for **30 days** at room temperature. This test confirms **photostability** and **long-term UV protection**.

**Table 12 : Sun Protection Factor**

Formulation	Initial SPF	SPF after 30 days
F1	14.8 ± 0.6	14.2 ± 0.5
F2	16.2 ± 0.7	15.8 ± 0.6
F3	19.1 ± 0.8	18.6 ± 0.7
F4	17.4 ± 0.5	16.9 ± 0.4

✓ Minimal SPF loss indicates good stability

### 3. Occlusivity Test

#### Description:

Occlusivity measures the ability of the cream to **reduce moisture loss from skin**, evaluated using a beaker method covered with filter paper.

**Table 13: Occlusivity Test**

Formulation	Occlusivity (%) (Mean ± SD)
F1	62.4 ± 1.8
F2	68.2 ± 2.1
F3	71.6 ± 1.9
F4	66.5 ± 2.0

✓ Higher occlusivity improves skin hydration

### 4. Bioadhesive Strength

#### Description:

Bioadhesive strength indicates how well the formulation **adheres to the skin**, ensuring longer residence time and sustained sunscreen effect.

**Table 14: Bioadhesive Strength**

Formulation	Bioadhesive strength (g, Mean ± SD)
F1	32.5 ± 1.2
F2	35.1 ± 1.4
F3	38.8 ± 1.6
F4	36.4 ± 1.3

✓ Higher value = better skin retention

### 5. Antioxidant Activity (DPPH Assay)

**Description:**

Herbal sunscreen creams are evaluated for antioxidant activity using the **DPPH free radical scavenging method**, as antioxidants help prevent UV-induced skin damage.

**Table 15: Antioxidant Activity**

Formulation	% Radical scavenging activity (Mean ± SD)
F1	61.2 ± 2.3
F2	65.8 ± 2.1
F3	74.5 ± 2.6
F4	68.4 ± 2.4

✓ Vitamin E formulation shows strongest antioxidant effect

### 6. Skin Sensory Evaluation (User Acceptability Test)

**Description:**

A small panel (5–10 volunteers) evaluated the cream for **smoothness, absorption, and after-feel** on a scale of 1–5.

**Table 16: Skin Sensory Evaluation**

Formulation	Sensory score (out of 5)
F1	4.1 ± 0.3
F2	4.2 ± 0.2
F3	4.7 ± 0.2
F4	4.4 ± 0.3

✓ Higher score indicates better cosmetic acceptability

All formulations exhibited acceptable physicochemical properties with smooth texture and uniform consistency. The pH values ranged between 6.3 and 6.6, which is suitable for topical skin applications.

Spreadability results showed that formulation F3 exhibited the highest spreadability, indicating improved application characteristics. Viscosity measurements also indicated that formulation F3 had optimal viscosity compared with other formulations.

SPF evaluation demonstrated that formulation F3 exhibited the highest SPF value ( $19.1 \pm 0.8$ ). This improved photoprotective activity may be attributed to the antioxidant properties of Vitamin E, which protects the skin from UV-induced oxidative damage [10].

## 5. Conclusion

The present study has been successfully formulated and evaluated herbal sunscreen creams using natural ingredients. All formulations demonstrated acceptable physicochemical characteristics and good stability.

Among the formulations, the Vitamin E-based formulation (F3) showed superior performance with the highest SPF value and optimal physicochemical properties. The findings indicate that herbal ingredients can be effectively utilized in sunscreen formulations to provide natural photoprotection and improved skin compatibility.

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