

**FORMULATION AND EVALUATION OF HERBAL TINTED
SUNSCREEN CREAM (USING ALOE VERA, TURMERIC, BEETROOT
EXTRACT, AND ZINC OXIDE FOR NATURAL UV PROTECTION: AN
IN VITRO EVALUATION FOR PHOTOAGING PREVENTION)**

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ABSTRACT

Ultraviolet (UV) radiation is one of the major factors responsible for skin damage, sunburn, pigmentation, premature aging, and other skin-related disorders. Although synthetic sunscreens are commonly used for protection against harmful UV rays, prolonged use may sometimes lead to skin irritation and other side effects. As a result, herbal sunscreen formulations have gained attention due to their better safety, natural origin, and skin-friendly properties.

The present study aimed to formulate and evaluate a herbal tinted sunscreen cream containing Aloe vera, Turmeric, Beetroot extract, and Zinc oxide for natural UV protection. Aloe vera was used for its moisturizing and soothing effect, turmeric for antioxidant and protective activity, beetroot for providing natural tint and antioxidant benefits, and zinc oxide as a mineral UV-blocking agent. The formulation was prepared by the emulsification method and evaluated for appearance, homogeneity, pH, spreadability, viscosity, stability, irritancy, and Sun Protection Factor (SPF).

The prepared cream showed good consistency, smooth texture, satisfactory spreadability, suitable pH, and good stability during the study period. The formulation also demonstrated

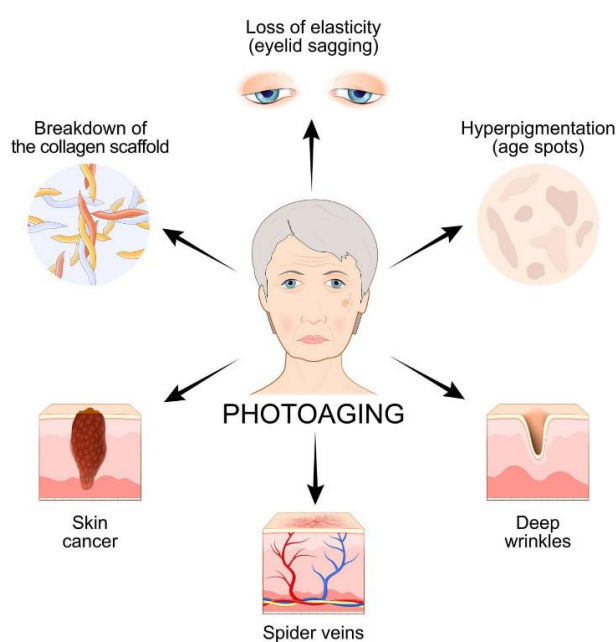
effective UV protective activity along with improved cosmetic appearance due to the natural tint of beetroot extract. The study suggests that the developed herbal tinted sunscreen cream may serve as a safe, stable, and effective natural sunscreen formulation for daily skin protection.

KEYWORDS: Aloe vera, Beetroot extract, Herbal sunscreen, Natural UV protection, Sun Protection Factor (SPF), Turmeric, Zinc oxide.

INTRODUCTION

Exposure to sunlight is one of the major causes of various skin problems such as sunburn, tanning, pigmentation, premature aging, and damage to skin tissues. Ultraviolet (UV) radiation present in sunlight mainly consists of UVA and UVB rays. UVA rays penetrate deeper into the skin and may lead to wrinkles and early aging, while UVB rays mainly affect the outer layer of the skin and are responsible for sunburn and irritation. Continuous exposure to these harmful rays may also increase oxidative stress and damage skin cells over time.

Sunscreens are widely used to protect the skin from the harmful effects of UV radiation. Most commercially available sunscreens contain synthetic chemical agents that help absorb or block UV rays. Even though these products are effective, prolonged use may sometimes cause skin irritation, allergies, and other unwanted side effects in sensitive individuals. Due to these concerns, there has been increasing interest in herbal and natural skincare products that are considered safer and more skin-friendly.



WHY DO WE NEED SUNSCREEN ?

Prevents Sunburn. Protects Against UV Radiation Reduces Risk of Skin Cancer. Prevents Premature Aging Maintains Even Skin Tone Protects DNA from Damage Prevents Sun Allergies Supports Overall Skin Health Natural ingredients with antioxidant and protective properties are commonly used in herbal cosmetic formulations. Aloe vera is widely known for its soothing, moisturizing, and cooling effects on the skin. Turmeric contains curcumin, which has antioxidant and anti-inflammatory properties that may help protect the skin from damage caused by UV exposure. Beetroot is rich in natural pigments and antioxidants and can also provide a natural tint to cosmetic products. Zinc oxide is a commonly used mineral sunscreen agent that provides broad-spectrum protection against both UVA and UVB rays. Combining herbal extracts with zinc oxide may improve UV protection while also enhancing skin compatibility and cosmetic appearance. In addition, the natural tint obtained from beetroot extract may help reduce the white appearance usually seen with mineral sunscreens, making the formulation more acceptable for regular use.

Therefore, the present study was carried out to formulate and evaluate a herbal tinted sunscreen cream containing Aloe vera, turmeric, beetroot extract, and zinc oxide for natural UV protection and improved cosmetic appeal.

AIM

The aim of the present study was to formulate and evaluate a herbal tinted sunscreen cream containing Aloe vera, Turmeric, Beetroot extract, and Zinc oxide for natural UV protection and improved cosmetic appearance.

OBJECTIVES

1. To prepare a herbal tinted sunscreen cream using herbal ingredients and zinc oxide.
2. To evaluate the physical properties of the prepared formulation.
3. To determine the pH, spreadability, homogeneity, and stability of the sunscreen cream.
4. To evaluate the Sun Protection Factor (SPF) of the prepared formulation.
5. To study the cosmetic appearance and skin compatibility of the formulation.
6. To develop a herbal sunscreen cream with effective UV protective activity and natural tinting properties.

Materials

The materials used for the preparation of the herbal tinted sunscreen cream included Aloe vera gel, Turmeric extract, Beetroot extract, Zinc oxide, beeswax, shea butter, coconut oil, almond oil, glyceryl monostearate, cetyl alcohol, Vitamin E oil, phenoxyethanol, and distilled water. All the ingredients used were of suitable pharmaceutical and cosmetic grade.

Table 1: Complete Quantitative Formulation Composition per 10 gm Batch.

S.NO	Ingredient Name	Physical Form	Experimental Quatity	Core Functional Role
1	Zinc oxide	Microfine Powder	1.00 g	Inorganic physical broad-spectrum UV filter
2	Aloe vera Gel	Purified Mucilage	4.00 g	Moisturizing vehicle, humectant, soothing agent
3	Beetroot Extract	Liquid Concentrate	0.30 g	Natural tinting agent, antioxidant source
4	Turmeric Powder	Standardized Extract	0.10g	Anti-inflammatory and antioxidant active
5	Coconut Oil	Fixed Pure Oil	1.50 ml	Emollient base and fatty acid source
6	Almond Oil	Fixed Pure Oil	1.50 ml	Skin-conditioning and texture-enhancing agent
7	Beeswax	Solid Waxy Flakes	0.50 g	Thickening and stabilizing agent
8	Shea Butter	Semi-Solid Fat	1.00 g	Moisturizing and lipid barrier repair agent
9	Vitamin E Oil	Viscous Liquid	0.10 ml	Antioxidant and formulation stabilizer
10	Vanilla Extract	Volatile Liquid	0.50 ml	Natural fragrance agent
11	Glyceryl Monostearate	Solid Flakes	0.40 g	Primary oil-in-water emulsifier
12	Cetyl Alcohol	Waxy Pellets	0.20 g	Co-emulsifier and consistency builder
13	Phenoxyethanol	Liquid Compound	0.05 ml	Antimicrobial preservative
14	Distilled Water	Purified Liquid	q.s. to 10 g Aqueous phase vehicle	Aqueous phase vehicle

Method of Preparation

The herbal tinted sunscreen cream was prepared by the emulsification method. The oil phase containing beeswax, shea butter, coconut oil, almond oil, glyceryl monostearate, cetyl alcohol, and zinc oxide was heated gently until completely melted. In another container, the aqueous phase containing distilled water and Aloe vera gel was heated separately to the same temperature.

The heated oil phase was slowly added to the aqueous phase with continuous stirring to form a smooth oil-in-water emulsion. The formulation was allowed to cool gradually with constant stirring. After cooling, beetroot extract, turmeric extract, Vitamin E oil, and preservative were added and mixed properly until a smooth and uniform cream was obtained. The prepared formulation was transferred into a suitable airtight container and stored for further evaluation.

Manufacturing Process

The herbal tinted sunscreen cream was prepared by the emulsification method. Coconut oil, almond oil, beeswax, shea butter, glyceryl monostearate, and cetyl alcohol were taken in a clean beaker and heated using a water bath at 70–75°C until the ingredients melted completely and formed a uniform oil phase. Zinc oxide was then added slowly to the melted mixture with continuous stirring to ensure proper dispersion without the formation of lumps. In another beaker, distilled water and Aloe vera gel were mixed and heated separately to the same temperature range of 70–75°C to prepare the aqueous phase.

The heated oil phase was gradually added to the aqueous phase with continuous stirring to form a smooth oil-in-water emulsion. The stirring process was continued for about 10 minutes to obtain a uniform cream base.

The prepared emulsion was then allowed to cool gradually under gentle stirring. When the temperature of the formulation dropped below 40°C, Beetroot extract, Turmeric powder, Vitamin E oil, vanilla extract, and phenoxyethanol were added slowly and mixed properly until a smooth and uniformly tinted cream was obtained.

Evaluation Parameters

Organoleptic Evaluation

The prepared herbal tinted sunscreen cream was evaluated for its physical appearance by visual inspection. Parameters such as color, odor, texture, consistency, and overall appearance were observed carefully. The formulation was checked for smoothness,

uniformity, and the presence of any visible particles or phase separation. The cosmetic appearance of the cream was also evaluated to determine its suitability for topical application.

pH Determination

The pH of the prepared formulation was determined using a calibrated digital pH meter. About 1 g of the sunscreen cream was accurately weighed and dispersed in 10 mL of distilled water. The mixture was allowed to stand for a few minutes to obtain a uniform dispersion. The pH was then measured at room temperature. The test was carried out to ensure that the formulation possessed a skin-compatible pH and would not cause irritation during application.

Homogeneity Test

The homogeneity of the formulation was evaluated by visual examination. A small quantity of the cream was applied on a clean glass slide and observed for uniformity in texture and appearance. The formulation was checked for the presence of lumps, coarse particles, or phase separation. A homogeneous cream indicates proper mixing of ingredients and good formulation stability.

Spreadability Study

Spreadability is an important parameter that determines the ease of application of the cream on the skin surface. The spreadability of the prepared sunscreen cream was evaluated using two glass slides. A small amount of cream was placed between the slides, and a certain weight was applied over them to allow uniform spreading of the formulation. The time taken by the upper slide to move a specific distance was noted, and spreadability was calculated.

Spreadability formula:

$$S = \frac{M \times L}{T}$$

Where:

S = Spreadability

M = Weight applied on the upper slide

L = Length moved by the slide

T = Time taken

Good spreadability indicates easy and uniform application of the cream on the skin.

Stability Study

The stability study was carried out to evaluate the physical stability of the prepared formulation during storage. The sunscreen cream was stored under different temperature conditions for a specified period of time. During the study, the formulation was observed for any changes in color, odor, texture, pH, consistency, and phase separation. Stability testing helps determine whether the formulation remains physically stable and suitable for use over time.

Irritancy Test

The irritancy test was performed to evaluate the skin compatibility of the prepared formulation. A small quantity of the cream was applied to a limited area of the skin and observed for signs of redness, itching, irritation, or swelling after application. The absence of irritation indicates that the formulation is safe for topical use.

Determination of Sun Protection Factor (SPF)

The Sun Protection Factor (SPF) of the prepared sunscreen cream was determined using UV spectrophotometric analysis. The absorbance of the formulation was measured at different wavelengths within the UV region, and the SPF value was calculated using the Mansur equation.

SPF formula:

$$SPF = CF \times \sum EE(\lambda) \times I(\lambda) \times Abs(\lambda)$$

Where:

CF = Correction factor

EE = Erythema effect spectrum

I = Solar intensity spectrum

Abs = Absorbance of the sample

The SPF value indicates the UV protective ability of the prepared sunscreen formulation.

Antioxidant Activity

The antioxidant activity of the formulation was evaluated to determine its ability to neutralize free radicals produced due to UV exposure. The presence of antioxidant-rich herbal ingredients such as turmeric and beetroot may help reduce oxidative stress and protect the skin from damage caused by free radicals.

Accelerated Stability Study

The prepared herbal tinted sunscreen cream was stored in sealed containers under accelerated stability conditions at 25 °C and 65% relative humidity for a period of 90 days. During the study, the formulation was evaluated at regular intervals of 30 days to observe any changes in color, odor, texture, pH, consistency, and phase separation. The study was carried out to determine the physical stability and suitability of the formulation during storage.

3.3 In Vitro Determination of Sun Protection Factor (SPF)

The Sun Protection Factor (SPF) of the prepared herbal tinted sunscreen cream was determined using the Mansur equation method. About 0.5 g of the formulation was dissolved in 10 ml of ethanol and sonicated for 10 minutes to obtain a uniform solution. The prepared solution was then filtered using a membrane filter. From the filtrate, 1 ml was further diluted to 10 ml using ethanol.

The absorbance of the sample was measured in the UVB region between 290-320 nm at intervals of 10 nm using a UV-Visible spectrophotometer, with ethanol used as the blank solution. The SPF value of the formulation was calculated using the following equation:

$$SPF = CF \times \sum_{290}^{320} EE(\lambda) \times I(\lambda) \times Abs(\lambda)$$

Where:

CF = Correction factor

EE() = Erythema effect spectrum

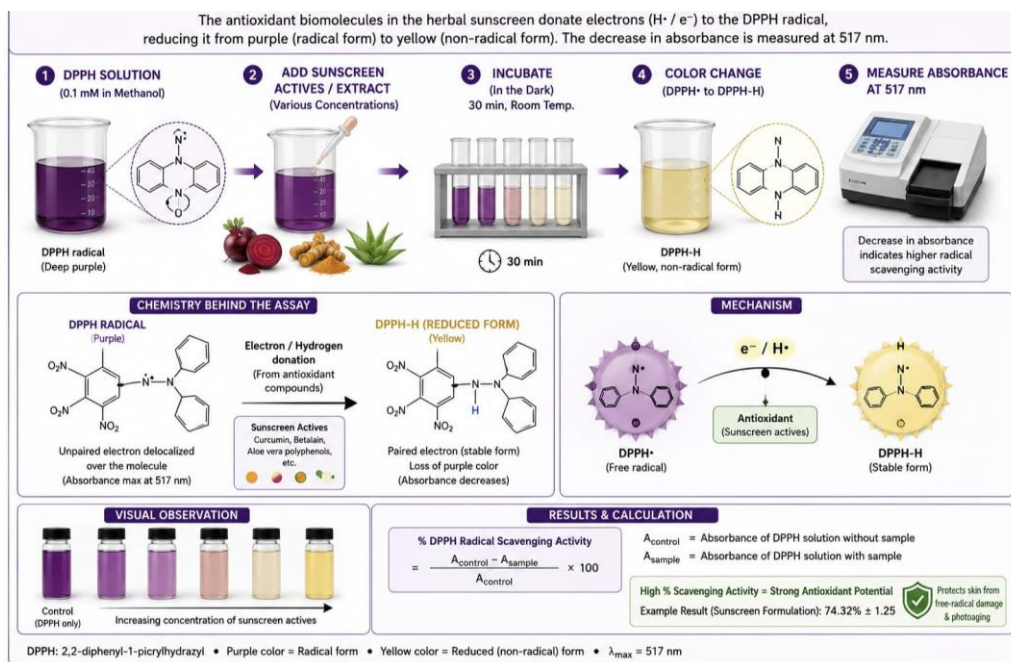
I() = Solar intensity spectrum

Abs() = Absorbance of the sample

3.4 In Vitro Antioxidant Activity by DPPH Assay

The antioxidant activity of the prepared formulation was evaluated using the DPPH free radical scavenging method. About 0.5 g of the cream was mixed with 5 ml of methanol and centrifuged to obtain the extract. Different aliquots of the supernatant solution (100 µl) were mixed with 1 ml of methanolic DPPH solution (0.1 mg/ml).

The reaction mixtures were kept in the dark at 25 °C for 30 minutes. After incubation, the absorbance was measured at 517 nm using a UV-Visible spectrophotometer. The percentage of DPPH radical scavenging activity was calculated using the following equation:



$$\% \text{ DPPH Scavenging Activity} = \left[\frac{A_{\text{control}} - A_{\text{sample}}}{A_{\text{control}}} \right] \times 100$$

This test was carried out to evaluate the antioxidant potential of the herbal ingredients present in the formulation.

RESULTS AND DISCUSSION

4.1 Physicochemical and Organoleptic Characterization

The finalized herbal tinted cream possessed a smooth consistency and a visually appealing peach-pink hue. The inclusion of beetroot extract successfully masked the typical chalky white cast of Zinc Oxide, resulting in an adjustable tint that blended smoothly into the skin upon topical application. The measured physical properties are summarized in

Table 2: Physicochemical Profile of the Developed Formulation.

Evaluation Results of Herbal Tinted Sunscreen Cream			
Evaluation Parameter	Observed Experimental Result	Standard Quality Target	Inference
Color Profile	Smooth Peach-Pink	Homogeneous cosmetic tint	Acceptable
Odor Character	Pleasant Vanilla-Botanical	Acceptable fragrance profile	Acceptable
pH Metric Value	6.32 ± 0.12	Skin-compatible (4.5 – 6.8)	Skin friendly
Spreadability (cm)	5.24 ± 0.18	Smooth application with uniform distribution	Good
Homogeneity	Highly Uniform	Free from grittiness or grain formation	Good
Type of Emulsion	Oil-in-Water (O/W Type)	Washable, non-greasy cosmetic texture	Good
Washability	Easily washable	Non-greasy, easy removal	Good
Irritancy	No redness or irritation observed	No skin irritation	Safe
Stability (90 days)	No phase separation observed and only slight pH variation within acceptable range	Physically & chemically stable under accelerated conditions	Stable
SPF Value (In vitro)	26.85 ± 1.05	Effective UV protective activity	Effective
Antioxidant Activity (DPPH Assay)	74.32% ± 1.45% (radical scavenging activity)	High antioxidant potential (>50% inhibition)	Effective

APPLICATION OF HERBAL TINTED SUNSCREEN CREAM



Environmental Stability and SPF Analysis

Stability Study

The stability of the prepared herbal tinted sunscreen cream was evaluated under accelerated storage conditions at and relative humidity for a period of 90 days. During the study period, the formulation was observed for changes in color, odor, pH, phase separation, and emulsion stability. The recorded observations are presented in Table 3.

Table 3: Accelerated Stability Profile of Herbal Tinted Sunscreen Cream.

Time line	Phase Seperation	Colour/odour change	Emulsion Status
Day0	Not Observed	No change	Stable emulsion
Day30	Not Observed	No change	Stable emulsion
Day60	Not Observed	No significant change	Stable emulsion
Day90	Not Observed	Slight fading observed	Satisfactory

The formulation remained physically stable throughout the study period without noticeable phase separation. Only a slight reduction in pH was observed during storage, but the values remained within the acceptable range for topical application. The stability of the formulation may be attributed to the presence of suitable emulsifying and stabilizing agents such as beeswax, glyceryl monostearate, and cetyl alcohol.

Spectrophotometric Analysis and SPF Profiling

The UV protective activity of the prepared formulation was evaluated using UV-Visible spectrophotometric analysis. The absorbance values were recorded within the UVB wavelength range of . The obtained value were used to calculate the Sun Protection Factor (SPF) using the Mansur equation.

CONCLUSION

The present study successfully formulated and evaluated a herbal tinted sunscreen cream containing Aloe vera, Turmeric, Beetroot extract, and Zinc oxide for natural UV protection. The prepared formulation showed good physical appearance, smooth texture, satisfactory spreadability, suitable pH, and good stability during the study period.

The formulation also demonstrated effective UV protective activity with an in vitro SPF value of and good antioxidant activity in the DPPH assay. The natural tint provided by beetroot extract improved the cosmetic appearance of the cream and helped reduce the white cast commonly associated with mineral sunscreens.

Overall, the developed herbal tinted sunscreen cream may serve as a safe, stable, skin-friendly, and effective formulation for daily use and natural protection against UV radiation.



Compliance and Declarations

Funding Statement

The present study did not receive any financial support or funding from any organization or agency.

Conflict of Interest

The authors declare that there is no conflict of interest related to this study.

Ethical Approval

This study was carried out using in vitro laboratory methods and did not involve human participants or animal studies.

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