

HERBAL TINTED SUNSCREEN-FORMULATION AND EVALUATION

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1. ABSTRACT

Sunscreen is a topical product used to protect the skin from the harmful effects of ultraviolet (UV) radiation, specifically UVA and UVB rays, which can cause sunburn, premature aging, and increase the risk of skin cancer. It functions either by absorbing UV radiation through chemical agents or by reflecting it using physical blockers. With rising awareness of the side effects associated with synthetic ingredients, there is a growing demand for natural, safe, and skin-friendly alternatives in sun care products. The incorporation of herbal materials into sunscreen is one of the most effective and natural ways to protect against the sun, as measured by the sun protection factor (SPF), as well as the detrimental side effects of toxic chemicals. In response to this demand, a herbal sunscreen formulation was developed using zinc oxide, aloe vera, turmeric (strong antiseptic property which protects skin from bacteria caused by excess sweat), coconut oil (used as a sun-block agent and helps to protect skin from sun damage), aloe vera (give a cooling effect to the skin and work as skin barrier), almond oil, beeswax, distilled water, vitamin E oil.

These ingredients are known for their gentle action on the skin and potential to provide broad-spectrum protection with added moisturizing and soothing benefits. The objective of this work is to formulate and evaluate a cosmetic (Herbal sunscreen) for protection of skin from the natural ingredients which have different properties such as emollient, moisturizer, base, anti-oxidant, anti-inflammatory in the ingredients such as curcuma, aloe vera, beeswax, etc.

Keywords: Herbal sunscreens with a coconut oil base, Antioxidant activity, Mutagenic activity, SPF.

2. INTRODUCTION

Sunscreen is a topical formulation designed to protect the skin from the harmful effects of ultraviolet (UV) radiation, including both UVA and UVB rays. Prolonged exposure to UV radiation can lead to sunburn, premature skin aging, hyperpigmentation, and increased risk of skin cancers such as melanoma and non-melanoma types. Sunscreens contain active ingredients that either physically block or chemically absorb UV radiation before it penetrates the skin.

Ultraviolet radiation is classified into three categories: UVA (320-400 nm), UVB (290-320 nm), and UVC (100-290 nm). Although UVC rays are mostly absorbed by the atmosphere, UVA and UVB rays reach the earth's surface and penetrate the skin. UVA radiation penetrates deeply into the dermis and is mainly responsible for photoaging, wrinkles, and long-term skin damage. UVB radiation primarily affects the epidermis and is the main cause of sunburn and DNA damage, leading to skin cancer. Therefore, effective protection against both UVA and UVB radiation is essential for maintaining skin health. Sunscreens are topical pharmaceutical or cosmetic formulations designed to protect the skin from harmful effects of UV radiation.

They function by either absorbing, reflecting, or scattering ultraviolet rays, thereby reducing their penetration into the skin. The formulation is assessed for its physiochemical characteristics, sun protection efficiency, stability, and safety, with the objective of providing an effective and user-friendly sunscreen product.

3. CLASSIFICATION OF SUNSCREEN

1. Based on Mechanism of Action

A. Physical (Inorganic) Sunscreens

- **Mechanism:** These act as a physical barrier, reflecting and scattering UV radiation away from the skin. They sit on the skin surface and begin working immediately after application.
- **Composition:** Contains mineral-based UV filters.
- **Common Ingredients:**
 - **Zinc oxide**—Provides broad-spectrum protection (UVA + UVB).
 - **Titanium dioxide**—effective mainly against UVB and short UVA rays.
- **Advantages:**
 - Less likely to cause skin irritation.
 - Safe for sensitive skin and children.

- Photostable (does not degrade in sunlight).
- **Disadvantages:**
- May leave a white chalky residue.
- Thick or greasy feel in some formulations.

B. Chemical (Organic) Sunscreens

- Mechanism: Absorb UV radiation and convert it into harmless heat. These penetrate slightly into the upper skin layers.
- **Composition:** Contains carbon-based organic compounds.
- **Common Ingredients:**
- Avobenzone—a broad-spectrum filter (especially UVA).
- Oxybenzone, octinoxate, and octocrylene mostly protect against UVB.
- **Advantages:**
- Lightweight and easy to spread.
- Transparent finish—suitable for everyday and cosmetic use.
- **Disadvantages:**
- May cause allergic reactions or skin sensitivity.
- Some degrade quickly under sunlight (photounstable) unless stabilized.

2. Based on the spectrum of UV protection,

A. UVB Filters

- Protect against short-wavelength **UVB rays (290–320 nm)** responsible for sunburn **and DNA damage**.
- Examples: Octinoxate, Homosalate, and Padimate O.
- Use: Prevent erythema (sunburn), especially in outdoor exposure.

B. UVA Filters

- **Target long-wavelength UVA rays (320–400 nm)** that penetrate deep into the skin, leading to aging, **wrinkles, and skin cancer**.
- Examples: Avobenzone, Mexoryl SX, and Tinosorb S.
- Use: Anti-aging, photodamage prevention.

C. Broad-Spectrum Sunscreens

- Combine UVA and UVB filters to provide comprehensive protection.
- Examples: Avobenzone + Octocrylene; Zinc oxide alone.
- Use: Ideal for daily protection, especially in regions with intense sunlight or high cancer risk.

D. Broad-Spectrum Sunscreens

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3. Based on Dosage Form (Formulation Type)

Sunscreens are available in various pharmaceutical formulations for targeted use and skin compatibility:

Formulation	Characteristics	Recommended For
Creams	Thick, moisturizing	Dry or sensitive skin
Lotions	Lighter, easy to apply	Normal skin
Gels	Non-greasy, quick - drying	Oily or acne-prone skin
Sprays	Convenient, large areas	Body application, reapplication
Sticks	Solid, no mess	Small areas (nose, lips, ears)
Powders	Tinted, easy to reapply	Face touch-ups, cosmetic finish
Tints	Colored for skin tone match	Hyperpigmentation, cosmetic use

Table 1: Based on Dosage Form

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4. Based on Application Purpose

A. Cosmetic sunscreens

- Used for daily UV protection with aesthetic appeal.
- Often contain moisturizers, makeup tints, or anti-aging ingredients.
- Examples: BB creams with SPF and tinted sunscreen lotions.

B. Medicinal or Therapeutic Sunscreens

- Used in dermatological conditions (e.g., melasma, photodermatitis, and lupus).
- Often prescribed by dermatologists.
- Broad-spectrum, high-SPF, and sometimes containing antioxidants or niacinamide.

C. Sports/Water-resistant Sunscreens

- Formulated for long-lasting, sweat-proof, and water-resistant use.
- Ideal for athletes, swimmers, or long outdoor activities.

5. Based on Regulatory Category

- **Over-the-counter (OTC) products:** Available without prescription for general use.
- **Prescription sunscreens:** Specialized formulations for patients with photosensitive disorders.
- **Reef-safe sunscreens:** Free from ingredients like oxybenzone and octinoxate to avoid environmental harm.

4. HERBAL -TINTED (PHYSICAL) SUNSCREEN

A sunscreen made with ingredients like carrot seed oil, zinc oxide, aloe vera gel, coconut oil, almond oil, beeswax, vanilla essence, cocoa powder, shea butter, distilled water, vitamin E oil, and turmeric falls under the category of **herbal-tinted(physical) sunscreen**. Zinc oxide is the primary active ingredient that provides broad-spectrum protection by physically blocking and reflecting both UVA and UVB rays, making it a physical (inorganic) UV filter. The presence of plant-based oils (coconut and almond), beeswax, shea butter as emollient, and herbal extracts like turmeric and aloe vera makes this formulation suitable for natural or herbal skincare. It also contains antioxidants (vitamin E and turmeric) and soothing agents (aloe vera), enhancing its role in preventing sun damage, soothing the skin, and offering mild antimicrobial and anti-inflammatory benefits. Bees wax acts as an emulsifier to blend oil and water phases, and the overall formulation is ideal for sensitive skin and eco-conscious consumers, without relying on synthetic chemical filters.

5. IMPORTANCE OF SUNSCREEN

Sunscreen is a vital skincare and dermatological product designed to protect the skin from harmful ultraviolet (UV) radiation, which includes UVA and UVB rays. Regular and correct use of sunscreen is crucial for maintaining healthy skin, preventing acute and chronic sun damage, and reducing the risk of skin diseases. It is an essential part of daily skin care and public health.

1. Protection from UV Radiation

Sunscreen protects the skin from **UVA and UVB rays**.

- **UVA rays** cause premature aging, wrinkles, and long-term skin damage.
- **UVB rays** are responsible for sunburn and play a major role in the development of skin cancer.

2. Prevention of Skin Cancer

Regular use of sunscreen significantly reduces the risk of **melanoma and non-melanoma skin cancers** by preventing DNA damage caused by UV exposure.

3. Prevention of Premature Aging

Sunscreen helps prevent **photoaging**, which includes fine lines, wrinkles, sagging, and loss of skin elasticity caused by prolonged sun exposure.

4. Protection Against Sunburn

Applying sunscreen reduces redness, inflammation, pain, and blistering associated with sunburn, especially during prolonged outdoor activities.

5. Maintenance of Even Skin Tone

Sunscreen helps prevent **hyperpigmentation, dark spots, melasma, and tanning**, maintaining a more even and healthy skin tone.

6. Protection in All Weather Conditions

UV rays can penetrate clouds and glass, making sunscreen important even on **cloudy days and indoors near windows**.

7. Supports Skin Health and Immunity

Excessive UV exposure can suppress local skin immunity. Sunscreen helps preserve the skin's natural defense mechanisms.

8. Essential for All Age Groups

Sunscreen is important for **children, adults, and the elderly**, as early protection reduces cumulative UV damage over a lifetime.

9. Complement to Other Sun Protection Measures

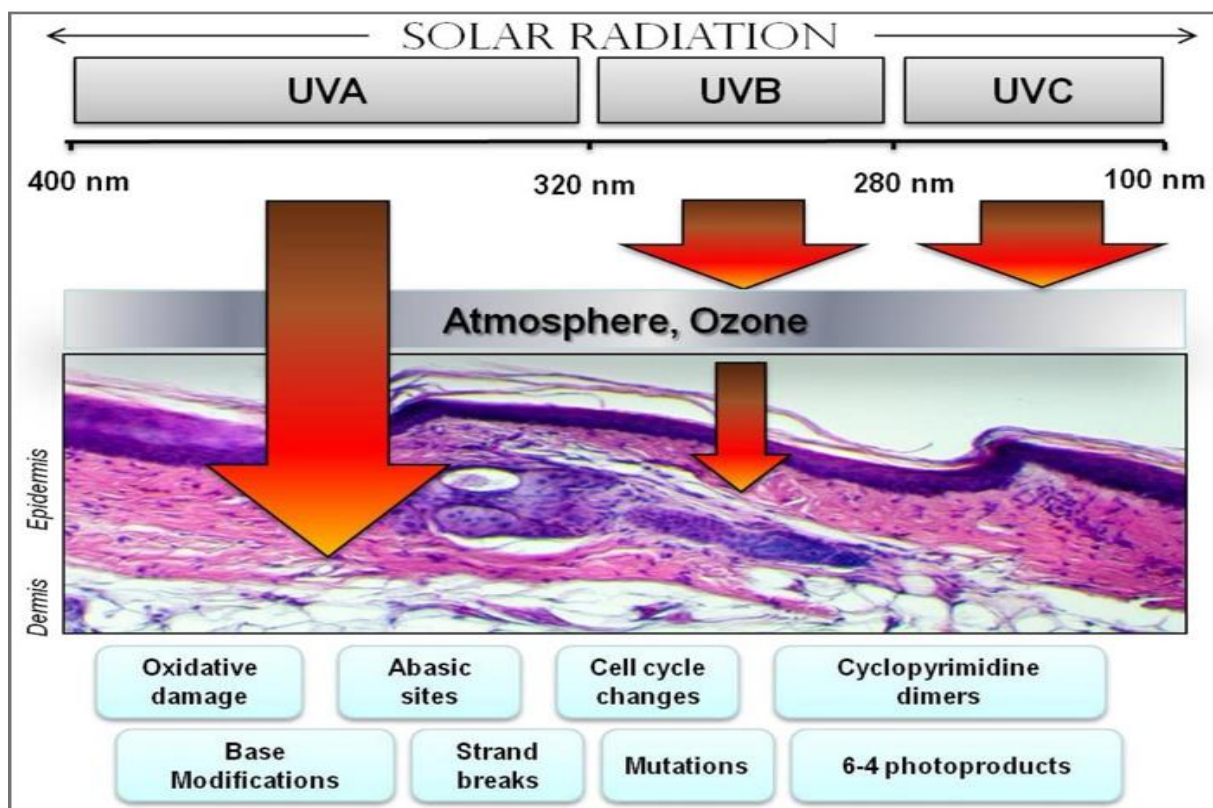
Sunscreen works best when combined with **protective clothing, hats, sunglasses, and shade**, offering comprehensive sun protection.

10. Importance in Tropical Countries

In countries like **India**, where sun exposure is intense year-round, daily sunscreen use is especially important to prevent long-term skin damage.



6. EFFECTS OF UV ON SKIN



Abundant in environment, UV contributes to a variety of skin maladies including inflammation, degenerative aging and cancer. Historically, humans have been exposed to UV radiation mainly through occupational exposure to sunlight. Recreational UV exposure, however, has increased dramatically in recent years because of outdoor leisure activities and to purposely tan for cosmetic purposes. Being a component of the electromagnetic spectrum, UV photons fall between the wavelengths of visible light and gamma radiation. UV energy can be subdivided into UV-A, -B and -C components based on electro physical properties, with UV-C photons having the shortest wavelengths (100–280 nm) and highest energy, UV-A having the longest (315–400 nm) but least energetic photons and UV-B falling in between (Figure 2). Each component of UV can exert a variety of effects on cells, tissues and molecules.

Figure 2. Electromagnetic spectrum of visible and UV radiation and biologic effects on the skin. Solar UV radiation can be subdivided into UVA, UVB and UVC components, however because of atmospheric ozone that absorbs UVC, ambient sunlight is predominantly UVA (90%–95%) and UVB (5%–10%). UV penetrates the skin in a wavelength dependent manner. Longer wavelength UVA penetrates deeply into the dermis reaching well into the dermis. In contrast, UVB is almost completely absorbed by the epidermis, with comparatively little reaching the dermis. UVA is efficient at generating reactive oxygen species that can damage DNA via indirect photosensitizing reactions. UVB is directly absorbed by DNA which causes molecular rearrangements forming the specific photoproducts such as cyclobutene dimers and 6–4 photoproducts. Mutations and cancer can result from many of these modifications to DNA.

Sun protection

Sun protection refers to the measures taken to shield the skin from harmful ultraviolet (UV) radiation and prevent sun-related damage. It includes the regular use of broad-spectrum sunscreens, wearing protective clothing, hats, and sunglasses, and avoiding direct sun exposure during peak hours. Effective sun protection helps prevent sunburn, photoaging, DNA damage, pigmentation, and skin cancer while maintaining overall skin health. Consistent sun-protective practices are essential for long-term skin safety in all age groups.

What is SPF?

The efficacy of a sunscreen is usually expressed by the sun protection factor (SPF), which is defined as the UV energy required to produce a minimal erythema dose (MED) on protected skin, divided by the UV energy required to produce a MED on unprotected skin (Equation 1):

$$SPF = \frac{\text{minimal erythema dose in sunscreen-protected skin}}{\text{minimal erythema dose in nonsunscreen-protected skin}}$$

The minimal erythema dose (MED) is defined as the lowest time interval or dosage of UV light irradiation sufficient to produce a minimal, perceptible erythema on unprotected skin (Wood et al., 2000; Wolf et al., 2001). The higher the SPF, the more effective is the product in preventing sunburn. Nevertheless, it is necessary to standardize methods to determine the SPF of these products. The photoprotection afforded by topical sunscreens against solar ultraviolet radiation exposure can be determined in vivo or in vitro, and it is ideally determined by photo testing in human volunteers. This type of determination has been used for many years and although useful and precise, is a time-consuming process, complex and expensive, particularly when information concerning to the protection against long wavelength (UVA) is required (Azevedo et al., 1999; Gasparro et al., 1998). As a consequence, much effort has been devoted to the development of in vitro techniques for assessing the photoprotection of sunscreen compounds. The methods in vitro are in general of two types. Methods which involve the measurement of absorption or the transmission of UV radiation through sunscreen product films in quartz plates or biomembranes, and methods in which the absorption characteristics of the sunscreen's agents are determined based on spectro photometric analysis of dilute solutions (Fourneron et al., 1999; Gordon, 1993; Mansur et al., 1986; Pissavini, M. et al., 2003; Walters et al., 1997).

Mansur et al. (1986), developed a very simple mathematical equation which substitutes the in vitro method proposed by Sayre et al., (1979), utilizing UV spectrophotometry and the following equation:

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

Where: EE (l) – erythema effect spectrum; I (l) solar intensity spectrum; Abs (l)- absorbance of sunscreen product; CF – correction factor (= 10). It was determined so that a standard sunscreen formulation containing 8% homosalate presented a SPF value of 4, determined by UV spectrophotometry (Mansur et al., 1986).

The values of $EE \times I$ are constants. They were determined by Sayre et al. (1979), and are showed in Table I. The aim of this research was to determine the SPF values of sunscreens emulsions containing chemical and physical sunscreens by UV spectrophotometry applying Mansur mathematical equation (Equation 2):

TABLE I - Normalized product function used in the calculation of SPF (Sayre et al., 1979) EE – erythema effect spectrum; I – solar intensity spectrum.

Wavelength (λ nm)	EE x I (normalized)
290	0.0150
295	0.0817
300	0.2874
305	0.3278
310	0.1864
315	0.0839
320	0.0180
Total	1

Table-1

7. AN IDEAL HERBAL SUNSCREEN AGENT SHOULD HAVE FOLLOWING CHARACTERISTICS:

- 1) Absorb light-weight preferentially over the vary of 280nm- 320nm.
- 2) Be stable to heat, lightweight and perspiration.
- 3) Be non-toxic and non-irritant.
- 4) Not be quickly absorbed.
- 5) Be speedy soluble in appropriate vehicle

8. MATERIALS REQUIRED:

a) ZINC OXIDE POWDER (NON-NANO): Zincite ore is the source of zinc oxide, a naturally occurring mineral. It is utilized in sunscreen in its nano, microfine, or purified form. One of the most popular and efficient physical (inorganic) UV filters is zinc oxide. By reflecting and scattering UVA and UVB rays, it offers broad-spectrum protection. It is safe for delicate skin, non-irritating, and photostable. Zinc oxide works instantly after application and lasts longer than many chemical filters. Additionally, it is eco-friendly. It is mixed with oils or emulsifiers in formulations to create smooth lotions or creams. Because of its anti-inflammatory and non-comedogenic qualities, it is also appropriate for baby products and skin prone to acne.

- b) **ALOE VERA GEL:** Extracted and dehydrated from the inner leaf gel of the aloe vera plant, a succulent that originated in North Africa but is now grown all over the world. Because of its calming, hydrating, and anti-inflammatory qualities, aloe vera powder is added to sunscreens. Although it doesn't function as a UV filter, it helps the skin by reducing redness and irritation following sun exposure. It has antioxidants, enzymes, polysaccharides, and vitamins A, C, and E that aid in skin repair. It enhances the way formulations feel on the skin and is particularly helpful in natural or herbal sunscreens for dry or sensitive skin types. It easily mixes with aqueous or cream-based formulations in its fine, water-soluble powder form.
- c) **COCONUT OIL:** The dried kernel or meat of mature coconuts, which are harvested from the coconut palm (*Cocos nucifera*), which is indigenous to tropical regions of Southeast Asia and the Pacific, is used to extract coconut oil. Because of its moisturizing, softening, and antimicrobial qualities, coconut oil is a common natural emollient used in sunscreen formulations. It is not a primary UV filter, but it does provide some natural UV protection (SPF of about 4–5). However, it provides a nourishing base, dissolves oil-soluble UV active ingredients or herbal extracts, and improves the spreadability and skin absorption.
- d) **ALMOND OIL:** The sweet almond tree (*Prunus amygdalus*), which is indigenous to the Middle East and South Asia, produces almond oil by cold pressing its seeds, or kernels. In sunscreen formulas, almond oil acts as a skin-nourishing carrier oil. It is high in phytosterols, omega-9 fatty acids, and vitamin E, all of which promote hydration, skin elasticity, and antioxidant activity. Despite having a low natural SPF of about 5, its benefits for skin conditioning and cosmetics make it more valuable.
- e) **BEESWAX:** Beeswax is a natural wax produced by honeybees (*Apis mellifera*) to build honeycombs. It is extracted from beehives and refined for use in medicine and cosmetics. In sunscreen formulations, beeswax is an essential thickening agent, emulsifier, and stabilizer. It helps combine the phases of water and oil into a homogenous emulsion by giving it a semi-solid consistency. Additionally, beeswax creates a breathable layer on the skin, contributing to the sunscreen's water resistance—a crucial characteristic for outdoor or athletic use.
- f) **VITAMINE OIL:** Vitamin E oil comes from plant-based oils like sunflower, wheat germ, or soybeans. Cosmetics typically use tocopherol or tocopheryl acetate. Vitamin E oil, a potent antioxidant, plays a crucial function in sunscreen compositions. Although it doesn't directly

filter UV rays, it shields skin cells from free radicals created by UV exposure. This prevents photoaging, like wrinkles, fine lines, and dark spots. It improves the stability of other chemicals, like oils and UV filters, avoiding oxidation over time. Vitamin E also helps to repair and soothe sun-damaged skin, as well as improve the skin's barrier. The antioxidant interaction with other vitamins, particularly Vitamin C, enhances total photoprotection.

g) VANILLA EXTRACT: Vanilla extract, derived from cured pods of *Vanilla planifolia*, is a popular ingredient in cosmetics and pharmaceuticals due to its pleasant aroma and skin advantages. Vanilla essential oil is commonly utilized in sunscreen formulations as a natural scent ingredient to promote product acceptability and consumer compliance. Unlike synthetic scents, vanilla oil has a pleasant, calming scent that is well-tolerated by skin.

h) TURMERIC: Turmeric is a bright yellow powder derived from the dried rhizomes of the *Curcuma longa* plant, indigenous to India and Southeast Asia. It contains curcumin, an active substance with therapeutic benefits. Turmeric is regarded in sunscreen due to its anti-inflammatory, antioxidant, and skin-brightening effects. Curcumin while not a UV filter, helps neutralize free radicals created by UV radiation, lowering oxidative stress and skin aging. It improves skin tone, reduces hyperpigmentation, and soothes sun-induced redness and inflammation. Turmeric is widely used in Ayurvedic and herbal preparations.

i) COCOA POWDER: Cocoa powder is a significant ingredient in sunscreen formulations because of its high antioxidant content, particularly flavonoids and polyphenols, which help neutralize free radicals produced by UV radiation. These antioxidants promote photoprotection, minimize oxidative stress, and prevent premature skin aging. Cocoa powder also has anti-inflammatory properties, helping to soothe UV-induced skin inflammation and redness. Furthermore, its natural bioactive properties can supplement UV filters and improve total skin protection, making cocoa powder an important natural and sustainable ingredient in sunscreen formulas.

j) CARROT SEED OIL: Carrot seed oil is useful in sunscreen formulations because it contains high levels of antioxidants, including carotenoids and vitamin E, which protect the skin from UV-induced oxidative damage. It has inherent photoprotective qualities that help defend against both UVA and UVB rays. Carrot seed oil also has anti-inflammatory and skin-repairing properties, which assist to heal sun-damaged skin and prevent premature aging. Furthermore, its emollient and moisturizing characteristics enhance skin barrier function, making it an important natural, multifunctional ingredient in sunscreen formulations.

k) SHEA BUTTER: Shea butter is a key ingredient in sunscreen formulations because of its strong emollient and hydrating characteristics, which serve to prevent dryness and maintain the skin barrier during sun exposure. It contains natural antioxidants including vitamins A and E, which protect the skin from UV-induced oxidative stress and premature aging. Shea butter also offers minor natural UV protection and anti-inflammatory properties, which soothe sun-irritated skin. It also increases the spreadability, stability, and skin feel of sunscreen formulations, making it an effective multifunctional base ingredient.

9. EQUIPMENTS REQUIRED

- Mortar and pestle
- Heating mantle (for melting waxes)
- Beaker
- Spatula
- Measuring balance
- Thermometer
- pH meter

10. INGREDIENTS REQUIRED

- Carrot Seed Oil
- Cocoa powder
- Shea butter
- Zinc Oxide Powder (Non-Nano)
- Aloe vera gel
- Coconut Oil
- Almond Oil
- Beeswax
- Turmeric (pinch)
- Vitamin E Oil
- Vanilla essence
- Distilled water

11. INGREDIENTS AND THEIR PURPOSE

Table 2: Ingredients and their purpose

INGREDIENTS	PURPOSE
Carrot seed oil	Natural antioxidant rich in carotenoids and tocopherols; provides adjunct photoprotective support by scavenging UV-induced free radicals, soothing inflammation, and conditioning the skin (not a primary UV filter).
Cocoa powder	Rich in polyphenols and flavonoids; acts as a potent antioxidant to neutralize UV-induced free radicals, helps reduce photo-oxidative stress and inflammation, supports skin photoprotection, and improves skin conditioning (adjunct role, not a primary UV filter).
Shea butter	Emollient rich in fatty acids, tocopherols, and triterpenes; improves skin barrier function, provides moisturizing and anti-inflammatory effects, and offers adjunct photoprotective support without acting as a primary UV filter.
Zinc Oxide	Broad-spectrum UV protection, suitable for sensitive skin, Reflects and scatters UVA & UVB rays
Aloe vera gel	Anti-inflammatory, moisturizing, cooling effect, Soothes sun-exposed or irritated skin
Coconut Oil	Softens skin, improves spreadability, has mild SPF (~4-5), Carrier oil and skin moisturizer
Almond Oil	Rich in vitamin E, antioxidant, improves skin barrier, Nourishing oil for hydration and spreadability.
Beeswax	Locks moisture, improves skin adherence, natural texture enhancer, Stabilizes and thickens the formulation, adds water resistance.
Turmeric	Brightens skin, helps reduce sun-related redness and irritation, Provides antioxidant and anti-inflammatory support.
Vitamin E Oil	Repairs skin, prevents aging, stabilizes oils in the formula, Protects skin from UV-induced oxidative stress.
Distilled Water	Water phase of the emulsion, dilutes and dissolves ingredient, Hydrates skin, makes product light and easy to spread.
vanilla extract	Antioxidant, anti-inflammatory and soothing effect, protect formulation stability, skin-conditioning agent, natural fragrance

12.METHODOLOGY

FORMULATION TABLE:

INGREDIENTS	WEIGHT(g) (F1)	WEIGHT(g) (F2)	ROLE
Beeswax	0.5g	0.5g	Thickening agent, emulsifier
Coconut oil	1.5ml	1.5ml	Emollient
Almond oil	1.5ml	1.5ml	Emollient
Shea butter	1.0g	1.0g	Moisturizer, consistency
Aloe vera gel	4.0g	4.0g	Aqueous base, soothing agent
Turmeric	-	0.1g	Antioxidant, tint
Cocoa powder	0.3g	0.3g	Natural tint
Zinc oxide	1.0g	1.0g	Physical UV blocker
Vitamin E	0.1g	0.1g	Antioxidant
Vanilla extract	0.05g	0.05g	Fragrance
Carrot seed oil	0.2ml	0.2ml	Natural UV protection
Distilled water	-	q.s. to 10g	Volume adjustment

TABLE:3 Formulations of Sunscreen

13. FORMULATION STEPS:

- All glassware, mortar, and pestle were thoroughly cleaned and dried.
- Required quantities of zinc oxide, cocoa powder, and turmeric were accurately weighed.
- The powders were transferred into a porcelain mortar and triturated uniformly to obtain a fine, homogeneous mixture.
- A small quantity of almond oil / coconut oil was added as a levigating agent.
- The mixture was triturated continuously until a smooth, lump-free paste was obtained.
- Shea butter and beeswax were melted together using a water bath.
- The melted oil phase was allowed to cool to room temperature.
- The oil phase was then added portion-wise to the levigated paste in the mortar.
- Continuous trituration was carried out to ensure uniform dispersion of zinc oxide.

- Aloe vera gel was added slowly in small portions with constant mixing.
- Trituration was continued until a smooth cream-like consistency was achieved.
- Vitamin E oil and vanilla extract were incorporated and mixed thoroughly.
- Final trituration was carried out to obtain a uniformly tinted, smooth formulation.
- The prepared herbal tinted sunscreen was transferred into a suitable container, labeled, and stored.

14. EVALUATION OF HERBAL – TINTED SUNSCREEN:

❖ Organoleptic Evaluation:

Organoleptic evaluation is based on parameters such as color, texture, and odour. These parameters are tested respectively by careful evaluation by a group, each partaking the tests. The test results are then recorded and submitted.

❖ Physical parameters:

- **Colour:** The colour of the formulation was checked manually and observed.
- **Odour:** The Smell of Formulation was checked by applying the preparation on hand and smelling the fragrance.
- **Appearance:** Visually checked the appearance of the formulation.
- ❖ **Determination of pH:** The pH of sunscreens was determined using a digital pH meter. The purpose of his study was to guarantee that the pH of the produced herbal sunscreens is similar to the pH of the skin after 24 hours of use. The results were triple-checked, and S.D. was recorded.
- ❖ **Determination of Viscosity:** The Brookfield viscometer was used to test viscosity, with the proper number of spindles selected. A 10ml beaker was used to hold 10g of preparation until the spindle groove was dipped and the rpm was set. Sunscreen viscosity was measured at 5, 10, 20, 50, and 100 rpm. The viscosity was computed using the factor obtained from the reading.
- ❖ **Spreadability:** The spreadability of sunscreens determined their therapeutic efficiency. The appropriate amount of sunscreen was applied between two slides, and under specified load directions, and the two sides took the time in seconds to slide off. Spreadability was defined as the amount of time it took to separate two slides in less time. The formula for calculating it is:

$S = M \times L / t$ Where; M = weight tied to the upper slide

L = length of glass slide

T = time taken to separate the slides

- ❖ **Washability:** This test is carried out by simply washing applied sunscreen lotion with water.
- ❖ **Homogeneity:** The formulation was tested for homogeneity by visual appearance and touch.
- ❖ **Skin irritation:** A test to check whether a cosmetic or pharmaceutical product causes redness, itching, or discomfort on the skin. It helps determine the safety and suitability of formulations for human use.
- ❖ **Stability Testing:** Stability testing of prepared formulation was conducted at room temp, studied for 7 days. And then the formulation was studied at $45 \pm 1^\circ\text{C}$ for 20 days. The formulation was kept both at room and elevated temperature and observed on 0th, 5th, 15th and 20th day for all the evaluation parameters.
- ❖ **Determination of SPF:** A UV-Visible spectrophotometer was used to examine the in- vitro efficacy of herbal sunscreens. A 0.10 percent solution (w/v) of herbal sunscreen lotions in ethanol was made by dissolving 0.050 g of herbal sunscreen lotions in 50.0 ml of ethanol. Between 290 and 320 nm, aliquots of each herbal sunscreen were scanned at 5 nm intervals. SPF was calculated using the equation below. Three times each sample was analyzed.

$$\text{SPF}_{in\ vitro} = CF \times \sum_{290}^{320} EE(\lambda) \times I(\lambda) \times \text{abs}(\lambda)$$

Whereas,

CF = Correction factor;

EE = Erythemogenic effect;

I = Intensity of solar light of wavelength;

A = Absorbance

15. RESULTS AND DISCUSSION

Results and Evaluation:

TABLE:4 Organoleptic Evaluation

S.NO:	Organoleptic characters	F1	F2
1	Colour	Brown	Yellowish brown
2	Odour	Floral aroma	Floral aroma
3	Texture	Fine and smooth	Fine and smooth
4	Appearance	Good	Good, pleasing
5	state	Semisolid	Semisolid



Fig: 2.1 Sunscreen (F1)



Fig:2.2 Sunscreen (F2)



Fig: 2.3 Sunscreen application



Fig: 2.4 After application

TABLE 5: Physicochemical properties:

Formulation No.	pH	Nature
F1	6.5-7	Mostly Neutral
F2	6.5-6.95	Mostly Neutral



Fig:3 Determination of pH

TABLE:6 Spreadability:

Formulation No.	Spreadability
F1	32.25
F2	28.66

TABLE:7 Stability:

Formulation No.	Phase Separation	Stability
F1	None	Stable
F2	None	Stable

TABLE:8 Homogeneity:

S. No:	Batch	Homogeneity
1.	F1	Homogenous
2.	F2	Homogenous

TABLE:9 Irritancy Test:

Formulation	Irritant effect	Erythema	Edema
F1	None	None	None
F2	None	None	None

TABLE:10 SPF Calculation:

Wavelength (nm)	EE(λ) x I(λ)	F1 Abs(λ) EE(λ) x I(λ)x Abs(λ)	F2 Abs(λ) EE(λ) x I(λ)x Abs(λ)
290	0.015	2.652 0.0397	2.786 0.0417
295	0.0817	2.953 0.2412	2.977 0.2432
300	0.2874	1.934 0.5558	1.900 0.5460
305	0.3278	2.686 0.8804	3.255 1.0669
310	0.01864	2.900 0.0540	2.950 0.0549
315	0.0837	1.975 0.1653	1.975 0.1653
320	0.018	2.836 0.0535	2.840 0.0535

		Total = 1.9899	Total = 2.1715
		SPF = 19.899	SPF = 21.715

Summary of Evaluation Results:

Two different formulations were prepared and evaluated. These formulations almost have same ingredients, but the second formulation has an addition of turmeric powder.

The first formulation (F1) was prepared by using Zinc oxide powder, aloe vera gel, coconut oil, almond oil, beeswax, vitamin E oil, vanilla extract, cocoa powder, carrot seed oil, and shea butter, were used to make the first formulation (F1). The organoleptic properties included a smooth, waxy texture, brown colour, and an aromatic Odor. The results of the physiochemical analysis were as follows:

- The pH was slightly acidic to neutral.
- There was no visible skin irritation.
- After application smooth texture.
- Smooth, homogenous, high-viscosity semi-solid cream.

Sun Protection Factor (SPF)

SPF 19.899 indicates that the sunscreen can block approximately 95% of UVB rays, providing moderate protection against sunburn and UV damage. It is suitable for daily use under normal conditions and short-term sun exposure, but may be insufficient for prolonged outdoor activities, sensitive or fair skin, or situations requiring stronger UV protection. This formulation of sunscreen was waxy and easy to use. It had good application on skin, and is non-irritant. It worked as a basic sunscreen, which can protect skin from UV rays and Sun Burn.

The second formulation (F2) was prepared by using Zinc oxide powder, aloe vera gel, vanilla extract, cocoa powder, Turmeric powder, coconut oil, almond oil, beeswax, vitamin E oil, carrot seed oil, shea butter. The organoleptic characteristics were bright yellow in colour, had an aromatic odour and a smooth and waxy texture.

The physiochemical evaluation was done, and these were the following results;

- The pH was slightly acidic to neutral.
- After application, it had a glossy texture.
- There was no visible skin irritation.

Sun Protection Factor (SPF)

SPF 21.715 provides strong and reliable protection, blocking approximately 95.4% of harmful UVB rays. This level of SPF is well-suited for daily wear, offering effective defense against sunburn and early signs of photoaging during regular outdoor activities. For most skin types, it strikes a great balance between performance and comfort, especially when applied and reapplied properly. This formulation of sunscreen was also waxy and easy to use. It had good application on skin, and is non-irritant. It worked as a basic sunscreen, which can protect skin from UV rays and Sun Burn.

Both formulations act as a basic minimalist sunscreen, which provides basic sun protection. Formulation 2 over Formulation 1 can be chosen, because it has slightly better SPF and includes turmeric, a natural antioxidant and anti-inflammatory agent that enhances the skin's defence against UV-induced damage. Even in a small amount, turmeric offers added photoprotection, helps reduce pigmentation, and supports overall skin health, making the formulation more effective without significantly altering its texture or appearance.

16. CONCLUSION:

In conclusion, this herbal-tinted sunscreen formulation provides a mild, effective, and skin-friendly alternative to traditional chemical sunscreens. The recipe combines zinc oxide with natural ingredients, including aloe vera gel, turmeric powder, coconut oil, almond oil, beeswax, vitamin E oil, cocoa powder, carrot seed oil, shea butter, and vanilla extract to protect against UVA and UVB radiation while also nourishing and soothing the skin. This formulation prioritizes safety, simplicity, and sustainability, addressing the growing desire in natural skincare products due to concerns about synthetic sunscreen side effects.

Incorporating elements with antioxidant, anti-inflammatory, and moisturizing characteristics improves the product's overall benefits and makes it ideal for regular use on all skin types. Additionally, the use of eco-friendly and biocompatible ingredients coincides with current skincare trends that prioritize personal wellness and environmental responsibility. This experiment demonstrates how nature-based formulations can suit modern skincare expectations while maintaining efficacy and safety.

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