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FORMULATION AND EVALUATION OF HERBAL SUNSCREEN LOTION CONTAINING ALOE VERA AND SANDALWOOD OIL

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ABSTRACT

The work in the present study involved the preparation and evaluation of herbal sunscreen lotion by using Aloe vera and sandalwood oil for proper skin protection. Prolonged UV radiation has resulted in erythema, hyperpigmentation, oxidative stress, aging and skin cancer as well, and there is a requirement to use sunscreen for protection of skin from UV rays. The trend of using herbal sunscreens is due to the potential of different plant constituents to exhibit antioxidant, emollient and moisturizing properties together with better cosmetic acceptance.

Preparation of sunscreen lotion: Aloe vera, sandalwood oil, almond oil, zinc oxide, stearic acid, cetyl alcohol, glycerine, vitamin E, Tween 80, propyl paraben and distilled water are mixed. The preparation was evaluated for its physical characteristics, pH, viscosity, thickness, spreadability, washability, dilution, after-feel, skin irritation, rancidity and thermal stability, its SPF value was 27.4. Good look, smooth spread, acceptable pH, no irritation and phase separation were observed.

Keywords: Herbal sunscreen, Aloe vera, sandalwood oil, SPF, lotion, photoprotection

INTRODUCTION

Human skin is continuously exposed to solar ultraviolet (UV) radiation, primarily UVA (320–400 nm) and UVB (280–320 nm), which can induce erythema, oxidative stress, inflammation, premature skin aging, hyperpigmentation, DNA damage, and skin cancer upon prolonged exposure **[1–4]**. Sunscreens are topical formulations designed

to protect the skin by absorbing, reflecting, or scattering UV radiation, thereby minimizing photodamage and reducing the risk of UV-induced skin disorders **[1, 5]**.

Growing concerns regarding the safety, environmental impact, and long-term use of certain synthetic sunscreen ingredients have stimulated interest in herbal and plant-based photoprotective formulations **[6, 7]**. Natural products possess a wide range of biological activities, including antioxidant, anti-inflammatory, antimicrobial, moisturizing, and skin-soothing effects, which may complement their photoprotective potential **[6-10]**. Plant-derived compounds rich in polyphenols, flavonoids, carotenoids, and vitamins have demonstrated the ability to neutralize reactive oxygen species generated during UV exposure and thereby help protect skin cells from oxidative damage **[8-10]**.

Aloe vera has gained considerable attention in dermatological and cosmetic preparations owing to its moisturizing, wound-healing, anti-inflammatory, and skin-protective properties **[11, 12]**. Its polysaccharides and bioactive constituents contribute to maintaining skin hydration and improving skin barrier function. Sandalwood oil (Santalum album) is another valuable natural ingredient widely used in cosmetic formulations due to its pleasant fragrance and reported antioxidant, anti-inflammatory, and soothing effects on the skin **[13, 14]**. Zinc oxide is a well-established physical sunscreen agent capable of providing broad-spectrum protection by reflecting and scattering both UVA and UVB radiation **[15, 16]**. Additionally, Vitamin E (α-tocopherol) serves as an important antioxidant that protects cellular membranes from lipid peroxidation and enhances the overall photoprotective efficacy of topical formulations **[9, 17]**.

Considering the beneficial properties of these natural and mineral ingredients, the present study was undertaken to formulate and evaluate a herbal sunscreen lotion containing Aloe vera and sandalwood oil. The formulation was assessed for its physicochemical characteristics, stability-related parameters, and in vitro sun protection factor (SPF) performance to determine its suitability as a safe and effective herbal photoprotective preparation.

AIM AND OBJECTIVES

To formulate and evaluate a herbal sunscreen lotion containing Aloe vera and sandalwood oil, assess its physicochemical properties, stability, safety, and in vitro SPF, and develop a natural, skin-friendly alternative for effective protection against ultraviolet radiation.

LITERATURE REVIEW

Herbal sunscreen formulations have gained significant attention due to the growing

demand for natural and safer cosmetic products. Several studies have reported the successful development of herbal creams and lotions containing plant-derived ingredients with antioxidant, anti-inflammatory, and photoprotective properties, demonstrating satisfactory physicochemical characteristics and SPF values (18–20).

Aloe vera is widely utilized in topical formulations because of its moisturizing, soothing, and skin-protective effects, which improve skin hydration and formulation acceptability **[21, 22]**. Sandalwood oil has also been incorporated into cosmetic and sunscreen preparations owing to its antioxidant and anti-inflammatory properties, along with its pleasant fragrance and skin-soothing benefits **[23, 24]**.

Recent investigations have highlighted the role of natural antioxidants in minimizing UV-induced oxidative stress and photoaging. Zinc oxide remains one of the most effective mineral sunscreen agents, providing broad-spectrum protection against UVA and UVB radiation and exhibiting good compatibility with herbal ingredients **[25, 26]**.

The efficacy of sunscreen formulations is commonly evaluated by determining the Sun Protection Factor (SPF). Among the available methods, UV spectrophotometric analysis using the Mansur equation is widely employed for the preliminary assessment of photoprotective activity because of its simplicity and reliability **[27, 28]**.

GAP IN LITERATURE

Many works were found on herbal sunscreen agents, but the studies done with combination of Aloe vera and sandal wood oil as sunscreen in lotion form with an extensive set of physicochemical, stability and SPF values were quite less. Thus, an attempt has been made in the present work to formulate such a formulation.

METHODOLOGY

Materials

Aloe vera gel, sandalwood oil, almond oil, stearic acid, cetyl alcohol, glycerin, zinc oxide, vitamin E, Tween 80, propyl paraben, and distilled water were procured from standard pharmaceutical-grade sources and used without further purification.

Equipment

The formulation and evaluation of the herbal sunscreen lotion were carried out using a digital weighing balance, heat-resistant glass beakers, mechanical stirrer, thermometer, water bath, pH meter, Brookfield viscometer, UV–Visible spectrophotometer, and airtight storage containers.

Formulation of Herbal Sunscreen Lotion

The herbal sunscreen lotion was prepared using the oil-in-water (O/W) emulsion

technique, which is commonly employed for topical sunscreen formulations because of its stability, spreadability, and patient acceptability **[29, 30]**.

Table 1: Composition of Herbal Sunscreen Lotion

Ingredient	Quantity	Function
Aloe vera	10 mL	Moisturizer and soothing agent
Sandalwood oil	2 mL	Fragrance and antioxidant agent
Almond oil	2 mL	Emollient
Stearic acid	2 g	Emulsifying and thickening agent
Cetyl alcohol	1.5 g	Stabilizer and viscosity enhancer
Glycerin	2 mL	Humectant
Zinc oxide	5 g	Physical sunscreen agent
Vitamin E	0.5 mL	Antioxidant
Tween 80	2 mL	Emulsifier
Propyl paraben	0.25 mL	Preservative
Distilled water	q.s. to 50 mL	Vehicle

Preparation Procedure

The aqueous phase was prepared by dispersing glycerin in distilled water, followed by the incorporation of Aloe vera gel under continuous stirring. Simultaneously, the oil phase comprising stearic acid, cetyl alcohol, almond oil, zinc oxide, and Tween 80 was heated separately. Both phases were maintained at 70–75°C to ensure complete melting and uniformity **[31, 32]**.

The oil phase was gradually added to the aqueous phase under continuous mechanical stirring to obtain a homogeneous oil-in-water emulsion. Stirring was continued until a smooth and uniform lotion was formed. After partial cooling, sandalwood oil, vitamin E, and propyl paraben were incorporated with gentle mixing to avoid volatilization and degradation of heat-sensitive constituents **[33, 34]**.

The pH of the formulation was adjusted to the physiological skin range (5.5–7.0), and the prepared lotion was transferred into airtight containers and stored at room temperature for further evaluation.

Evaluation of Herbal Sunscreen Lotion

The prepared formulation was evaluated for appearance, color, homogeneity, pH, viscosity, spreadability, washability, irritancy, dilution stability, thermal stability, rancidity, and in vitro Sun Protection Factor (SPF). The pH was determined using a calibrated digital pH meter, while viscosity was measured using a Brookfield viscometer. Spreadability was assessed by the slip-and-drag method. The SPF was estimated using UV-visible spectrophotometry according to the Mansur method, which is widely accepted for the preliminary evaluation of sunscreen efficacy **[27, 28, 35]**. Stability studies were conducted under different storage conditions to evaluate the physical stability and suitability of the formulation for topical application.

Evaluation of Herbal Sunscreen Lotion

The formulated herbal sunscreen lotion was evaluated for physicochemical characteristics, stability, safety, and photoprotective efficacy using standard analytical methods **[36, 38]**.

Organoleptic Properties and Homogeneity

The formulation was examined visually for color, odor, appearance, consistency, and texture. Homogeneity was assessed by visual inspection and tactile examination to ensure the absence of grittiness, phase separation, or aggregation **[36]**.

pH Determination

The pH of the lotion was measured using a calibrated digital pH meter after suitable dilution with distilled water. The evaluation was performed to ensure compatibility with the physiological pH of the skin **[37]**.

Viscosity Measurement

Viscosity was determined using a Brookfield viscometer under controlled conditions to assess the flow characteristics and consistency of the formulation, which influence product stability and ease of application **[37, 38]**.

Spreadability

Spreadability was evaluated using the glass-slide method and calculated using the following equation **[39]**:

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

where S is spreadability, M is the applied weight, L is the length of the glass slide, and T is the time required for separation of the slides.

Washability and After-Feel

Washability was assessed by observing the ease of removal of the formulation with water. After-feel was evaluated for smoothness, greasiness, emollience, and residual film characteristics following topical application **[40]**.

Dilution Test

The emulsion type was confirmed by dilution with water. Uniform dilution without phase separation indicated an oil-in-water (O/W) emulsion system **[38]**.

Irritancy Test

The formulation was applied to a small area of skin and monitored for 24 h for signs of erythema, edema, itching, or irritation **[41]**.

Rancidity and Thermal Stability

Rancidity was evaluated to detect oxidative deterioration of lipid components, while thermal stability studies were conducted under controlled temperature conditions to assess phase separation, creaming, and physical instability **[42]**.

In Vitro Sun Protection Factor (SPF)

The SPF of the formulation was determined by UV–Visible spectrophotometry in the wavelength range of 290–320 nm at 5 nm intervals. SPF was calculated using the Mansur

equation, a widely accepted method for preliminary assessment of sunscreen efficacy **[27, 28, 43]**:

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

where *CF* is the correction factor (10), *EE(λ)* is the erythemal effect spectrum, *I(λ)* is the solar intensity spectrum, and *Abs(λ)* is the absorbance of the formulation at wavelength λ.

RESULTS

Prepared herbal sun cream lotion showed acceptable organoleptic and physicochemical properties. These findings were represented as follows:

Table 2: Evaluation Parameters of Herbal Sunscreen Lotion

Sr. No.	EVALUATION PARAMETERS	RESULT/OBSERVATION
1	Color	Pale cream
2	Odor	Pleasant characteristic odor
3	Appearance	Smooth and uniform
4	Homogeneity	Homogeneous with no grittiness
5	pH	6.53
6	Viscosity	Good viscosity with satisfactory consistency
7	Spreadability	Easily spreadable
8	Washability	Easily washable with water
9	Dilution test	Stable oil-in-water (O/W) emulsion
10	After-feel	Non-greasy and smooth feel
11	Irritancy test	No irritation, redness, or edema observed
12	Rancidity test	No pink color observed
13	Thermal stability	No phase separation observed
14	SPF value	27.4

DISCUSSION

The formulated herbal sunscreen lotion demonstrated satisfactory physicochemical characteristics, indicating the successful development of a stable oil-in-water emulsion system. The formulation exhibited good appearance, homogeneity, and consistency, which are important attributes for patient acceptability and uniform topical application **[44, 45]**.

The pH value of 6.53 was within the normal physiological range of the skin, suggesting good compatibility and a reduced risk of irritation following topical use **[45]**. The observed viscosity and spreadability indicated suitable rheological properties, facilitating easy application and uniform distribution of the lotion over the skin surface. Furthermore, the dilution test confirmed the oil-in-water nature of the formulation, a desirable characteristic for sunscreen lotions because of their non-greasy feel, ease of spreading, and improved washability **[44, 46]**.

No signs of erythema, edema, rancidity, phase separation, or physical instability were observed during the evaluation period, indicating satisfactory preliminary safety and stability of the prepared formulation. The stability of the emulsion may be attributed to the appropriate combination of emulsifying

and stabilizing agents used in the formulation **[46, 47]**.

The in vitro SPF value of 27.4 demonstrated moderate to high photoprotective efficacy. This protective effect can be primarily attributed to zinc oxide, which provides broad-spectrum protection against both UVA and UVB radiation through reflection and scattering mechanisms **[48, 49]**. In addition, Aloe vera, sandalwood oil, and vitamin E may contribute antioxidant and anti-inflammatory activities that help reduce UV-induced oxidative stress and support skin protection **[50, 52]**.

The findings are in agreement with previous reports demonstrating that herbal sunscreen formulations containing botanical ingredients and mineral UV filters can provide effective photoprotection along with additional skin-conditioning benefits **[53, 54]**. Therefore, the developed formulation may serve as a promising natural sunscreen preparation. However, further investigations involving accelerated stability studies, microbial quality assessment, and in vivo SPF evaluation are necessary to confirm its long-term effectiveness and safety **[55]**.

CONCLUSION

A herbal sunscreen lotion incorporating Aloe vera and sandalwood oil was prepared and assessed. It showed satisfactory physicochemical properties, acceptable spreadability and skin compatible pH, some stability and had no indications of irritation on skin. The SPF value determined was found to be 27.4 which indicates its suitability as an herbal cosmetic lotion used for protection against sun rays. So, the herbal formulation prepared can be used as a good alternative for synthetic sun screening products.

FUTURE SCOPE

Additional studies could include accelerated stability, long term storage and microbiological analysis, in vivo determination of SPF, as well as comparison with commercial sunscreen preparations. Additional optimization utilizing sophisticated carrier systems or new herbal actives could also enhance product performance and commercialization potential.

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