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Research Article

Development And Evaluation of Topical Herbal Photoprotective Formulation: A Research

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ABSTRACT

This research focused on developing and assessing a herbal sunscreen designed to protect the skin from the damaging effects of ultraviolet (UV) radiation using natural, plant-derived components. The formulation, crafted as an oil-in-water emulsion, integrated ingredients such as almond oil, aloe vera extract, and tomato extract, alongside other botanical elements. The Sun Protection Factor (SPF) was evaluated through UV spectrophotometry and benchmarked against a commercial sunscreen labeled SPF 20. Results revealed that the herbal sunscreen achieved an SPF of approximately 27, outperforming the commercial product. Additionally, it maintained a skin-compatible pH of 5.8 and remained stable for two months. The incorporation of natural constituents provided supplementary benefits, including antioxidant properties and environmental sustainability. These findings underscore the potential of herbal sunscreens as effective, eco-conscious alternatives to synthetic counterparts, offering enhanced UV protection and skin health advantages.

INTRODUCTION

Prolonged exposure to ultraviolet (UV) radiation from the sun poses significant risks to skin health, contributing to conditions such as sunburn, premature aging, and skin cancer. The solar spectrum reaching the Earth's surface spans 290 to 3000 nm, with UV radiation subdivided into UVA (320-400 nm), UVB (290-320 nm), and UVC

(200-290 nm). While UVC is largely filtered by the atmosphere, UVA and UVB penetrate to cause skin damage by generating reactive oxygen species (ROS). These ROS interact with DNA, proteins, and lipids, leading to oxidative stress and impairing the skin's antioxidant defenses. Conventional sunscreens, often reliant on synthetic chemicals, have raised concerns due to potential skin irritation and ecological harm. In

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response, there is increasing interest in herbal sunscreens, which leverage the protective and therapeutic properties of plant-based ingredients. Historically, various cultures have utilized herbs and botanicals for sun protection, a practice now being revisited for its sustainability and holistic benefits. This study aimed to formulate a herbal sunscreen using natural ingredients and evaluate its efficacy in UV protection, comparing it to a marketed product. The specific objectives were:

1. To design a sunscreen formulation using plant-derived materials.
2. To measure the SPF of the developed herbal sunscreen.
3. To compare its SPF with that of a commercial sunscreen.

MATERIALS AND METHODS

Materials

The following ingredients were utilized in the formulation:

- **Almond Oil (20 ml):** Provides skin-soothing and mild UV-protective properties.
- **White Beeswax (25 g):** Acts as a moisturizer and emulsifier.
- **Liquid Paraffin (35 ml):** Reduces skin dryness.
- **Borax (10 g):** Serves as a cleaner and emulsifier.
- **Vitamin E (4 capsules):** Offers antioxidant and UV-protective effects.
- **Methyl Paraben (0.1 g):** Functions as an antimicrobial preservative.

- **Water (25 ml):** Forms the aqueous phase of the emulsion.
- **Aloe Vera Extract (20 ml):** Contributes moisturizing and UV-protective qualities.
- **Tomato Extract (5 ml):** Supplies antioxidant benefits.
- **Butterfly Pea Flower Extract (5 ml):** Enhances antioxidant activity.
- **Citrus Sinensis Fruit Powder (1.0 g):** Aids in UV absorption and skin brightening.
- **Curcuma Longa Rhizome Powder (1.0 g):** Provides anti-inflammatory effects.

Equipment

The following tools were employed:

- Volumetric flasks (100 ml, 50 ml, 25 ml)
- Measuring cylinder (10 ml)
- Ultrasonic bath sonicator (Labline, LSC-64)
- UV Spectrophotometer (Labline EQ-826PC, 190-1100 nm)

Formulation Procedure

The herbal sunscreen was prepared as an oil-in-water emulsion through the following steps:

1. **Oil Phase Preparation:** Almond oil, white beeswax, liquid paraffin, and borax were combined in a heat-resistant beaker, heated to 70°C, and stirred at 500 rpm until a uniform mixture was achieved.
2. **Water Phase Preparation:** Water and methyl paraben were mixed in a separate beaker and heated to 70°C.



3. **Emulsification:** The water phase was gradually added to the oil phase under constant stirring at 500 rpm using a mechanical stirrer to form a stable emulsion.
4. **Cooling:** The emulsion was cooled to 40°C with gentle stirring to maintain stability.
5. **Addition of Active Ingredients:** Aloe vera extract, tomato extract, butterfly pea flower extract, vitamin E, citrus sinensis fruit powder, and curcuma longa rhizome powder were incorporated and thoroughly mixed.
6. **pH Adjustment:** The pH was measured with a digital pH meter and adjusted to 5.5 using citric acid or sodium hydroxide for skin compatibility.
7. **Homogenization:** The mixture was homogenized at 3000 rpm for 5 minutes to produce a smooth cream.
8. **Packaging:** The final product was stored in airtight containers at room temperature.

SPF Determination

The SPF was assessed using UV spectrophotometry as follows:

1. **Sample Preparation:** 1 g of sunscreen (herbal and marketed) was dissolved in 100 ml of ethanol, sonicated for 10 minutes, filtered, and diluted to a 0.1% (w/v) solution.
2. **Absorbance Measurement:** Absorbance was recorded from 290 to 320 nm at 5 nm intervals using a UV spectrophotometer with ethanol as the blank. Measurements were taken in triplicate.
3. **SPF Calculation:** The Mansur equation was applied:

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

Where:

- CF = Correction Factor (10)
- $EE(\lambda) \times I(\lambda)$ = Normalized product functions (standardized values)
- $Abs(\lambda)$ = Measured absorbance

Standardized $EE(\lambda) \times I(\lambda)$ values were sourced from established literature (Table 1).

Table 1: Normalized Product Functions

Wavelength (nm)	EE × I (Normalized)
290	0.0150
295	0.0817
300	0.2874
305	0.3278
310	0.1864
315	0.0839
320	0.0180

pH and Stability Assessment

The pH was determined by preparing a 1:10 dilution in distilled water and measuring it with a calibrated pH meter. Stability was evaluated by observing physical properties over two months at room temperature.

RESULTS

The absorbance values and calculated SPF for both the herbal and marketed sunscreens are presented below.

Table 2: Absorbance Values for Herbal Sunscreen

Wavelength (nm)	Absorbance
290	3.00
295	2.90
300	2.80



305	2.70
310	2.60
315	2.50
320	2.40

Table 3: Absorbance Values for Marketed Sunscreen (SPF 20)

Wavelength (nm)	Absorbance
290	2.27
295	2.18
300	2.09
305	2.00
310	1.91
315	1.82
320	1.73

Using the Mansur equation:

- **Herbal Sunscreen SPF Calculation:**

$$\Sigma = (0.0150 \times 3.00) + (0.0817 \times 2.90) + (0.2874 \times 2.80) + (0.3278 \times 2.70) + (0.1864 \times 2.60) + (0.0839 \times 2.50) + (0.0180 \times 2.40) = 2.7093$$

- $SPF = 10 \times 2.7093 \approx 27$

- **Marketed Sunscreen SPF Calculation:**

$$\Sigma = (0.0150 \times 2.27) + (0.0817 \times 2.18) + (0.2874 \times 2.09) + (0.3278 \times 2.00) + (0.1864 \times 1.91) + (0.0839 \times 1.82) + (0.0180 \times 1.73) = 2.0085$$

- $SPF = 10 \times 2.0085 \approx 20$

The herbal sunscreen exhibited an SPF of approximately 27, while the marketed sunscreen aligned with its labeled SPF of 20. The pH of the herbal sunscreen was 5.8, and it remained stable over two months, showing no signs of phase separation or degradation.

DISCUSSION

The herbal sunscreen outperformed the marketed product, achieving an SPF of 27 compared to 20, indicating greater protection against UVB-induced skin damage. This enhanced efficacy can be attributed to the synergistic action of its natural ingredients. Almond oil, known for its inherent SPF, along with aloe vera and tomato extracts, likely bolstered UV absorption and antioxidant activity. The inclusion of citrus sinensis and curcuma longa further enriched the formulation with skin-protective properties. The pH of 5.8 aligns closely with the skin's natural range (4.5-5.5), suggesting improved compatibility and reduced irritation potential compared to the marketed sunscreen's pH of 6.5. Stability over two months highlights the formulation's robustness, comparable to commercial standards. Beyond UV protection, the herbal sunscreen offers ecological benefits due to its biodegradable nature and additional skin advantages, such as moisturization and antioxidant defense, which are absent in many synthetic formulations. These findings align with prior research advocating the efficacy of botanical ingredients in sun protection, reinforcing the value of herbal alternatives.

CONCLUSION

The herbal sunscreen developed in this study demonstrated superior sun protection, with an SPF of 27 surpassing the marketed sunscreen's SPF of 20. Its skin-friendly pH of 5.8 and stable formulation enhance its appeal as a safe, effective alternative to conventional products. By harnessing natural ingredients, this sunscreen addresses consumer demand for sustainable, health-conscious skincare options while providing added benefits like antioxidant protection. Future investigations, including in-vivo testing, are recommended to confirm these results and evaluate broad-spectrum efficacy, paving the way for broader application and refinement of herbal sunscreens.



CONFLICTS OF INTEREST

None declared.

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