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Formulation and Evaluation of Herbal Sunscreen Cream

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Abstract

In an era where synthetic chemicals and environmental stressors pose significant risks to skin health, natural ingredients offer a safe and effective alternative for sun protection. Ultraviolet (UV) radiation from the sun is a leading cause of skin damage, including sunburn, premature aging, and an increased risk of skin cancers such as melanoma and squamous cell carcinoma. Sunscreen formulations are critical for mitigating these effects by absorbing, reflecting, or scattering UV rays. This study focuses on the development and evaluation of a herbal sunscreen cream incorporating bioactive plant extracts, including Citrus sinensis (orange peel), Aloe vera, Daucus carota (carrot oil), and Curcuma longa (turmeric). These ingredients were selected for their photoprotective, antioxidant, and anti-inflammatory properties. The formulated cream was evaluated for physical properties, sun protection factor (SPF), and skin compatibility, achieving an SPF of 26, indicating broad-spectrum UV protection. This research highlights the potential of herbal sunscreens as eco-friendly, safe alternatives to synthetic products, with implications for both cosmetic and dermatological applications.

Introduction

The harmful effects of ultraviolet (UV) radiation on human skin are well-documented, ranging from acute sunburn to chronic conditions such as photoaging and skin cancer. UV radiation is categorized into three types: UVA (320–400 nm), UVB (290–320 nm), and UVC (100–290 nm). While UVC is largely absorbed by the Earth's atmosphere, UVA and UVB penetrate to the skin, causing damage to the dermis and epidermis, respectively. Sunscreens are topical formulations designed to protect the skin by absorbing or reflecting UV radiation, thereby reducing its penetration into deeper skin layers. Synthetic sunscreens, while effective, often contain chemicals such as oxybenzone and octinoxate, which have been associated with adverse effects, including skin irritation, hormonal disruptions, and environmental damage. In contrast, herbal sunscreens leverage the photoprotective and antioxidant properties of plant-derived compounds, such as flavonoids, phenolic acids, and essential oils, to provide a safer alternative. The aim of this study was to formulate a herbal sunscreen cream using natural ingredients known for their UV-blocking, antioxidant, and skin-nourishing properties. The selected ingredientsAloe vera, Citrus sinensis peel, Daucus carota oil, and Curcuma longa—were chosen based on their established efficacy in phot Protection and skin care. This paper explores the formulation process, evaluation parameters, and potential benefits of herbal sunscreens, emphasizing their role in reducing reliance on synthetic chemicals. By combining traditional herbal knowledge with modern pharmaceutical techniques, this study aims to contribute to the development of sustainable and skin-friendly sun protection products. Sunscreen is a chemical that protects the skin from ultraviolet light. Sunburn is caused by UV B but UV A is capable of inflicting more damage to the skin. It is best to have sunscreen that blocks both wavebands. The application aim of this study was to formulate a topical herbal sunscreen containing some fixed oils and a variety of medicinal herbs. Daily use of sunscreen can prevent actinic keratosis, melanoma, and squamous cell carcinoma. [1] There are two types of sunscreen chemicals: inorganic and organic. A sunscreen product can also be called a sunscreen lotion if it protects skin from the damaging effects of UV rays by either reflecting or absorbing them. Complication increased rates of incidence of skin cancers and photodamage of UV has led to the increasing use of sun block products. Sunscreen have shown to encourage positive outcomes in the reduction of symptoms. The compounds found in sunscreen products should be completely safe, free from chemicals, non-irritating, non-toxic, photostabilized and provide skin with some protection from the sun.[2] Skin cancers, photodamage, and sunburn are outcomes of the degree of above. As the negative effects of UV radiation, new sunscreen formulations must be developed to increase SPF, treat sunburn/suntans, prevent skin cancer, and reduce skin age. The formulation of sunscreen would achieve greater protection from

Aim:

To formulate and evaluate an effective herbal sunscreen cream using natural plant extracts with photoprotective and skin-nourishing properties.

Objectives:

To identify and select herbal ingredients with proven photoprotective, antioxidant, and skin beneficial properties (e.g., Aloe vera, Turmeric, Orange peel, Carrot oil).
To extract and process active phytoconstituents from selected herbal sources.

To formulate a stable and skin-friendly herbal sunscreen cream using these extracts.
To evaluate the prepared formulation for physical parameters such as pH, viscosity, spreadability, and homogeneity.
To determine the Sun Protection Factor (SPF) of the herbal sunscreen using appropriate methods.
To assess the safety and skin compatibility of the formulation through irritancy and after-feel tests.
To compare the herbal sunscreen's effectiveness with standard synthetic sunscreen products.

Ideal Properties of Herbal Sunscreen Cream

An effective herbal sunscreen cream must meet several criteria to ensure safety, efficacy, and user acceptability. These properties include:
1.Broad-Spectrum UV Absorption: The cream should preferentially absorb UV radiation in the 280–320 nm range (UVB) and 320–400 nm range (UVA) to provide comprehensive protection.
2. Water and Heat Resistance: The formulation should remain stable under exposure to water, heat, and perspiration, ensuring long-lasting protection.
3. Non-Toxic and Non-Irritating: The cream should be free from harmful chemicals, non-sensitizing, and safe for prolonged use.
4. Stability: The product must remain stable under varying environmental conditions, including sunlight exposure, without degrading or losing efficacy.
5. Aesthetic Appeal: A non-greasy texture, minimal odor, and easy spreadability enhance user compliance.
6. Antioxidant and Anti-Inflammatory Effects: Ingredients should counteract oxidative stress and inflammation caused by UV exposure.
7. Eco-Friendliness: The use of renewable, biodegradable ingredients minimizes environmental impact.
These properties ensure that the herbal sunscreen is both effective and suitable for diverse skin types, including sensitive skin.

Mechanism of Photoprotection

Sunscreens protect the skin through two primary mechanisms: physical and chemical photoprotection. Physical sunscreens, often containing mineral-based ingredients like zinc oxide or titanium dioxide, reflect and scatter UV rays, preventing their penetration into the skin. Chemical sunscreens, on the other hand, absorb UV radiation and convert it into harmless heat energy. Herbal sunscreens combine these mechanisms by utilizing plant-derived compounds that absorb UV rays and neutralize reactive oxygen species (ROS) generated by UV exposure. Flavonoids and phenolic compounds in plants such as Citrus sinensis and Curcuma longa act as natural UV filters, absorbing radiation in the UVA and UVB ranges. Additionally, antioxidants like vitamin C (from orange peel) and curcumin (from turmeric) scavenge free radicals, reducing oxidative damage to skin cells. Aloe vera provides a soothing effect, repairing UV-induced damage, while Daucus carota oil enhances skin barrier function and absorbs UVB rays. This synergistic action makes herbal sunscreens effective in preventing sunburn, photoaging, and UV-induced carcinogenesis.

Materials and Methods

Plant Materials

The herbal sunscreen cream was formulated using the following plant-derived ingredients, selected for their photoprotective and skin-nourishing properties:

1. Aloe vera (Liliaceae)

- Biological Source: Derived from the dried latex of Aloe vera leaves.
- Description: Clear to slightly yellow, translucent gel with a bitter taste and garlic-like odor.
- Chemical Constituents: Contains aloe-emodin, polysaccharides, and anthraquinones.
- Uses: Soothes sunburn, moisturizes the skin, and promotes wound healing.

2. Turmeric (Curcuma longa, Zingiberaceae)

- Biological Source: Obtained from the dried rhizomes of Curcuma longa.
- Description: Yellow powder with an aromatic odor and bitter taste.
- Chemical Constituents: Curcumin, curcuminoids, and volatile oils.
- Uses: Provides anti-inflammatory, antioxidant, and skin-brightening effects.

3. Orange Peel (Citrus sinensis, Rutaceae)

- Biological Source: Derived from the peel of Citrus sinensis (sweet orange).
- Description: Orange to deep orange powder with a tangy odor and sweet taste.
- Chemical Constituents: Limonene, citral, and high levels of vitamin C.
- Uses: Enhances collagen synthesis, brightens skin, and provides antioxidant protection.

4. Carrot Oil (Daucus carota, Apiaceae)

- Biological Source: Extracted from the roots of Daucus carota.
- Description: Orange to purplish-red oil with a pungent odor and earthy taste.
- Chemical Constituents: Beta-carotene, vitamins A and E, and essential fatty acids.
- Uses: Absorbs UVB rays, promotes skin brightening, and prevents premature aging.

Other Ingredients

The formulation included additional ingredients to enhance stability, texture, and efficacy:
- Stearic Acid: Thickener and emulsifier.
- Cetyl Alcohol: Co-emulsifier for improved cream consistency.
- Almond Oil: Moisturizer and anti-aging agent.
- Glycerol: Humectant to retain skin moisture.
- Methylparaben: Preservative to prevent microbial growth.
- Rose Water: Fragrance and skin soother.
- Triethanolamine: Surface-active agent for pH adjustment.
- Carbopol: Gelling agent for viscosity control.
- Vitamin E: Antioxidant to protect against oxidative stress.
- Coconut Oil: Moisturizer and skin barrier enhancer.
- Borax: Inhibits microbial growth.
- Beeswax: Provides photostability and improves texture.

Instrumentation

The following instruments were used for formulation and evaluation:
- pH meter
- Brookfield viscometer
- UV-visible spectrophotometer
- Hot air oven
- Hot plate
- Digital weighing balance

Preparation of Herbal Extracts

1. Turmeric Extract:
- Dry Curcuma longa rhizomes were powdered and packaged to avoid contamination.
- 10 g of turmeric powder was macerated in 150 mL of 90% ethanol for 15 hours at room temperature.
- The extract was filtered, purified in a round-bottom flask at constant temperature for 1 hour, and stored in a cool environment for further use.

2. Orange Peel Powder:
- Fresh oranges were sourced from a local market in Washim.
- Peels were cleaned, dried in a hot air oven at 75°C for 15 minutes, and pulverized into a fine powder.

3. Aloe Vera Gel:
- Fresh *Aloe vera* leaves were harvested, and the gel was extracted by cutting and scooping the inner leaf content.
- The gel was processed to remove impurities and stored under refrigeration.

4. Carrot Oil:
- Fresh carrots were peeled, grated, and dried in a hot air oven at 75°C for 15 minutes.
- The dried carrots were infused in coconut oil under sunlight for 48 hours, filtered, and stored for use.

Formulation of Herbal Sunscreen Cream

The cream was prepared in three steps:
1. Oil Phase: Stearic acid, cetyl alcohol, almond oil, carrot oil, coconut oil, and vitamin E were melted together on a hot plate at 75°C.
2.Aqueous Phase: Methylparaben, glycerol, starch, triethanolamine, and herbal extracts were dissolved in water and heated to 75°C.
3.Emulsification: The oil and aqueous phases were mixed with continuous stirring until a homogeneous cream was formed. The final product was transferred to a glass container for evaluation.

Evaluation Parameters

The formulated cream was evaluated for the following parameters:

1. Physical Appearance: Color, odor, and texture.
2. pH: Measured using a pH meter to ensure skin compatibility (ideal range: 5.5–7.0).
3. Viscosity: Determined using a Brookfield viscometer to assess flow properties.
4. Homogeneity: Checked for uniformity and absence of granules.
5. Spreadability: Evaluated by applying the cream on skin to measure ease of application.
6. Rancidity: Tested to ensure oxidative stability.
7. Washability: Assessed for ease of removal with water.
8. Irritancy Test: Applied to skin to check for redness or irritation.
9. After-Feel: Evaluated for greasiness and skin comfort post-application.
10. Sun Protection Factor (SPF): Measured using UV-visible spectrophotometry to determine UV-blocking efficacy.

Results

The herbal sunscreen cream was successfully formulated with a smooth, non-greasy texture and a pleasant appearance. Key evaluation results include:
- Physical Properties: The cream exhibited a light yellowcolor, mild herbal odor, and homogeneous texture.
- pH: The pH was within the skin-compatible range of 6.0–6.5, ensuring safety for topical use.
- Viscosity: The cream demonstrated optimal viscosity, allowing easy application without excessive thickness.
- Spreadability: The formulation spread evenly on the skin, providing a uniform protective layer.
- Homogeneity: No phase separation or granulation was observed, indicating a stable emulsion.
- Rancidity: The cream showed no signs of oxidative degradation during storage.
- Washability: The cream was easily removed with water, enhancing user convenience.
- Irritancy: No signs of redness or irritation were observed, confirming skin compatibility.
- After-Feel: The cream left a non-greasy, moisturizing feel on the skin.
- SPF: The formulation achieved an SPF of 26, indicating effective protection against UVB radiation and moderate protection against UVA rays.

These results demonstrate that the herbal sunscreen cream is a viable alternative to synthetic products, offering both efficacy and safety.

Discussion

The development of herbal sunscreens addresses growing consumer demand for natural, eco-friendly, and skin-safe products. The selected ingredientsAloe vera, Curcuma longa, Citrus sinensis peel, and Daucus carota oil—contribute to the formulation's efficacy through their synergistic effects. Aloe vera soothes UV-induced inflammation, while turmeric's curcumin provides potent antioxidant and anti-inflammatory benefits. Orange peel's high vitamin C content supports collagen synthesis and skin brightening, and carrot oil's beta-carotene enhances UVB absorption and skin nourishment. The SPF value of 26 indicates that the cream can protect the skin from approximately 96% of UVB rays, comparable to many commercial sunscreens. The absence of irritation and rancidity further supports the formulation's suitability for sensitive skin and long-term use. Compared to synthetic sunscreens, which may cause allergic reactions or environmental harm, this herbal formulation offers a sustainable alternative with minimal ecological impact. Future research could focus on optimizing the formulation for higher SPF values, incorporating additional plant extracts, or conducting in vivo studies to validate long-term efficacy and safety. Standardization of herbal extracts and large-scale production techniques will also be critical for commercial applications.

Conclusion

This study successfully formulated and evaluated a herbal sunscreen cream using Aloe vera, Curcuma longa, Citrus sinensis peel, and Daucus carota oil. The cream exhibited desirable physical properties, including proper pH, viscosity, spreadability, and homogeneity, with an SPF of 26, indicating effective UV protection. The absence of irritation, rancidity, and greasiness highlights its suitability for topical use across various skin types. By leveraging the photoprotective, antioxidant, and anti-inflammatory properties of natural ingredients, this formulation offers a safer and more sustainable alternative to synthetic sunscreens. With further refinement and clinical validation, herbal sunscreens hold significant promise for cosmetic and dermatological applications, aligning with the global shift toward natural and eco-friendly products.

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