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Formulation and Evaluation of a Novel Herbal Sunscreen Cream Containing Murraya Koenigii, Moringa Oleifera and Erythrina Variegata Extracts

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Abstract

Background: The increasing awareness regarding the adverse effects of synthetic sunscreen agents has created a growing demand for herbal photoprotective formulations. Medicinal plants containing flavonoids, phenolic compounds, and antioxidants can provide protection against harmful ultraviolet (UV) radiation while offering additional skin benefits.

Objective: The present study was aimed at formulating and evaluating a herbal sunscreen cream containing ethanolic extracts of Murraya koenigii, Moringa oleifera, and Erythrina variegata for effective UV protection and skin compatibility.

Materials and Methods: The selected plant materials were collected, authenticated, dried, powdered, and extracted using ethanol. Three cream formulations (F1, F2, and F3) were prepared using varying concentrations of herbal extracts. The prepared creams were evaluated for physicochemical properties including pH, viscosity, spreadability, irritancy, phase separation, and stability. UV spectrophotometric analysis and phytochemical screening were performed to assess photoprotective potential and the presence of bioactive constituents. In vitro Sun Protection Factor (SPF) values were determined using the Mansur method.

Results: Phytochemical screening revealed the presence of alkaloids, flavonoids, phenols, tannins, and steroids in the extracts. UV spectrophotometric analysis demonstrated significant absorption in the UV region with λmax around 270 nm, indicating the presence of UV-absorbing phytoconstituents. The formulated creams showed good homogeneity, acceptable viscosity, satisfactory spreadability, and no significant irritation. SPF values of formulations F1, F2, and F3 were 14.5, 13.4, and 11.2, respectively, demonstrating moderate photoprotective activity.

Conclusion: The herbal sunscreen cream formulated using Murraya koenigii, Moringa oleifera, and Erythrina variegata exhibited promising photoprotective potential, good physicochemical characteristics, and satisfactory safety profiles. The study supports the use of herbal ingredients as natural alternatives in sunscreen formulations.

Keywords: Herbal sunscreen; Murraya koenigii; Moringa oleifera; Erythrina variegata; photoprotection; UV radiation; SPF; phytochemicals.

Introduction

Ultraviolet (UV) radiation emitted from sunlight is one of the major environmental factors responsible for acute and chronic skin damage. Continuous exposure to UV radiation can result in erythema, hyperpigmentation, photoaging, immunosuppression, oxidative stress, DNA damage, and skin cancer [1,2]. Among the different UV radiations, UVB (290–320 nm) is primarily responsible for sunburn and direct DNA damage, whereas UVA (320–400 nm) penetrates deeper into the skin and contributes to premature aging and oxidative damage [3].

Sunscreens are topical formulations designed to protect the skin by absorbing, reflecting, or scattering harmful ultraviolet radiation. Conventional sunscreens commonly contain synthetic UV filters such as oxybenzone, avobenzone, and octinoxate [4]. Although these compounds provide effective photoprotection, concerns have been raised regarding skin irritation, allergic reactions, endocrine disruption, and environmental toxicity [5,6]. Consequently, there has been increasing interest in the development of herbal sunscreen formulations using plant-derived bioactive compounds.

Herbal sunscreens offer several advantages over synthetic formulations due to their antioxidant, anti-inflammatory, moisturizing, and photoprotective properties. Plant-derived phytochemicals such as flavonoids, phenolic acids, tannins, carotenoids, and alkaloids possess the ability to absorb ultraviolet radiation and neutralize reactive oxygen species generated by UV exposure [7]. These properties contribute to enhanced skin protection and reduced oxidative stress.

Murraya koenigii, commonly known as curry leaf, is rich in carbazole alkaloids and antioxidant compounds that exhibit antimicrobial, anti-inflammatory, and free radical scavenging activities. Moringa oleifera contains vitamins, minerals, flavonoids, and phenolic compounds known for their antioxidant and skin-protective effects. Erythrina variegata possesses several bioactive constituents including flavonoids and alkaloids that contribute to antioxidant and therapeutic activities [8,9].

The present investigation was undertaken to formulate and evaluate a herbal sunscreen cream containing extracts of Murraya koenigii, Moringa oleifera, and Erythrina variegata. The prepared formulations were assessed for physicochemical properties, phytochemical constituents, spreadability, viscosity, irritancy, stability, and in vitro sun protection factor (SPF) to determine their suitability as natural photoprotective cosmetic products.

Materials and methods

Plant Materials

The medicinal plants selected for the present study were Murraya koenigii, Moringa oleifera, and Erythrina variegata. Fresh plant materials were collected from the local market of Cuddalore, Tamil Nadu, India. The collected specimens were authenticated by the Department of Botany, Periyar Government Arts College, Cuddalore.

Preparation of Plant Extracts

The collected leaves were thoroughly washed with distilled water to remove dust and foreign materials. The cleaned leaves were shade dried at room temperature and pulverized into coarse powder using a mechanical grinder. Approximately 20 g of each powdered sample was extracted with ethanol using a Soxhlet extraction method. The extraction process was continued for 6–8 h until complete extraction of phytoconstituents was achieved. The obtained extracts were filtered and concentrated using a rotary evaporator. The concentrated extracts were stored in airtight containers under refrigerated conditions until further use [10].

Preliminary Phytochemical Screening

The ethanolic extracts were subjected to preliminary phytochemical screening for the detection of major secondary metabolites including alkaloids, flavonoids, phenols, tannins, saponins, terpenoids, cardiac glycosides, steroids, and carbohydrates using standard qualitative procedures. The tests performed included Wagner's test for alkaloids, alkaline reagent test for flavonoids, ferric chloride test for tannins, Salkowski test for terpenoids, Keller–Kiliani test for cardiac glycosides, foam test for saponins, Molisch test for carbohydrates, and a sulfuric-acid-based test for steroids.

UV Spectrophotometric Analysis

UV spectrophotometric analysis was carried out using a double-beam UV–Visible spectrophotometer. One milliliter of each ethanolic extract was diluted to 10 mL using distilled water and scanned in the

wavelength range of 200–400 nm. The maximum absorbance wavelength (λmax) was recorded for each extract.

Formulation of Herbal Sunscreen Cream

Three formulations of herbal sunscreen cream (F1, F2, and F3) were prepared using different concentrations of herbal extracts. The oil phase consisted of stearic acid, cetyl alcohol, liquid paraffin, and olive oil. The aqueous phase contained glycerin, triethanolamine, methyl paraben, propyl paraben, herbal extracts, and purified water. The oil phase and aqueous phase were heated separately to approximately 70°C. The aqueous phase was slowly added to the oil phase with continuous stirring until a smooth and homogeneous cream was obtained. The prepared formulations were transferred into suitable containers and stored at room temperature.

Determination of Sun Protection Factor

The in vitro SPF values were determined using the Mansur equation [16]. One gram of each formulation was dissolved in ethanol and diluted appropriately. The absorbance was recorded between 290 and 320 nm at intervals of 5 nm using a UV spectrophotometer.

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

where CF represents the correction factor, EE(λ) represents the erythemal effect spectrum, I(λ) represents the solar intensity spectrum, and Abs(λ) represents the absorbance of the sample.

Evaluation of Herbal Sunscreen Cream

Physical Appearance

The creams were visually examined for color, homogeneity, consistency, and phase separation.

pH Determination

The pH of each formulation was measured using pH paper and compared with the normal skin pH range.

Viscosity

Viscosity measurements were performed using a Brookfield viscometer at 25°C with spindle number 6 at 10 rpm.

Spreadability

Spreadability was determined using the slide separation method. The time required for separation of two glass slides under a specified load was recorded and used to calculate spreadability.

Stability Study

The formulations were subjected to accelerated stability testing according to ICH guidelines at 40 ± 2°C and 75 ± 5% relative humidity for three months. Changes in physical appearance, pH, viscosity, and phase separation were monitored.

Irritancy Test

The irritancy potential of the prepared creams was evaluated by observing redness, inflammation, itching, or irritation after topical application.

Results and discussion

Phytochemical Screening

Preliminary phytochemical screening of the ethanolic extracts revealed the presence of several biologically active constituents responsible for antioxidant and photoprotective activities. Flavonoids were detected in all three plant extracts, while alkaloids and phenolic compounds were present in varying concentrations. These phytochemicals are known to possess free-radical-scavenging and UV-absorbing properties, which contribute to the sunscreen potential of herbal formulations [12].

Phytochemical	Murraya koenigii	Moringa oleifera	Erythrina variegata
Alkaloids	++	+	++

Flavonoids	++	++	++
Phenols	+	++	+
Saponins	−	+	−
Tannins	+	+	+
Steroids	−	−	+

Note: ++ = Highly positive; + = Moderately positive; − = Negative.

The results indicate that Moringa oleifera possesses a higher concentration of phenolic compounds, while Murraya koenigii and Erythrina variegata contain abundant alkaloids and flavonoids. The presence of these compounds supports the antioxidant and photoprotective potential of the formulation [13].

UV Spectrophotometric Analysis

UV spectrophotometric analysis was carried out to evaluate the UV absorption characteristics of the herbal extracts. All extracts demonstrated significant absorbance in the ultraviolet region. Murraya koenigii exhibited a major absorption peak around 270 nm with a secondary shoulder peak near 320 nm. Moringa oleifera also showed maximum absorbance around 270 nm, indicating the presence of phenolic and flavonoid compounds. Erythrina variegata displayed a similar UV absorption pattern with notable absorbance in the UVB region. These findings confirm the presence of UV-absorbing phytochemicals capable of providing photoprotective activity [14].

Evaluation of Herbal Sunscreen Cream

The prepared formulations were smooth, homogeneous, and free from grittiness. No evidence of phase separation was observed during the study period. The creams showed acceptable consistency and were easily washable with water.

Viscosity Study

The viscosity values of the formulations were found to be within the acceptable range for topical creams. Among the formulations, F2 exhibited the highest viscosity, suggesting improved structural stability and consistency. The observed viscosity values were suitable for topical application and ensured ease of handling.

Formulation	Extract concentration (%)	Viscosity (cP)
F1	0.5	20,500
F2	1.0	24,000
F3	1.5	18,500

Spreadability Study

Spreadability is an important parameter affecting patient acceptability and ease of application. The formulation containing Murraya koenigii demonstrated better spreadability due to its lower separation time and higher spreadability value. Good spreadability ensures uniform distribution of sunscreen over the skin surface.

Extract	Time (s)	Spreadability (g·cm/s)
Moringa oleifera	7	2.16
Murraya koenigii	4	3.00
Erythrina variegata	8	2.40

Irritancy Study

The irritancy study revealed that the prepared formulations were safe for topical application.

Extract	Irritation score	Category
Murraya koenigii	0	Non-irritant; Safe
Moringa oleifera	0–1	Minimal irritation; Very safe
Erythrina variegata	1–2	Mild irritation; Use with caution

No significant redness, itching, or inflammation was observed following application of the formulations, confirming their dermatological safety [15].

Sun Protection Factor (SPF) Determination

The SPF values obtained by the in vitro method indicated moderate photoprotective activity for all formulations. The SPF results suggest that all formulations provide measurable protection against UVB radiation. Among the formulations, F1 exhibited the highest SPF value, indicating superior photoprotective activity. The SPF values obtained may be attributed to the presence of flavonoids, phenols, and other UV-absorbing phytoconstituents present in the plant extracts.

Formulation	SPF value
F1	14.5
F2	13.4
F3	11.2

Overall, the results demonstrated that the formulated herbal sunscreen creams possessed desirable physicochemical characteristics, acceptable stability, non-irritancy, and moderate sun-protection potential [16]. The synergistic action of Murraya koenigii, Moringa oleifera, and Erythrina variegata contributed to the overall effectiveness of the formulation.

CONCLUSION

The present study successfully formulated and evaluated a herbal sunscreen cream containing extracts of Murraya koenigii, Moringa oleifera, and Erythrina variegata. The selected medicinal plants were found to contain several bioactive phytoconstituents including flavonoids, phenols, tannins, and alkaloids that contribute to antioxidant and photoprotective activities. The prepared formulations exhibited satisfactory physicochemical properties such as good homogeneity, smooth texture, acceptable viscosity, excellent spreadability, and absence of phase separation. The formulations were also found to be safe for topical application as evidenced by the non-irritancy test results. UV spectrophotometric analysis confirmed the presence of UV-absorbing compounds in the plant extracts, while in vitro SPF evaluation demonstrated moderate photoprotective activity. Among the formulations, F1 exhibited the highest SPF value (14.5), indicating superior photoprotective activity, whereas F2 demonstrated better viscosity and formulation stability. These findings suggest that the combination of Murraya koenigii, Moringa oleifera, and Erythrina variegata can be effectively utilized in the development of herbal sunscreen formulations.

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6. CONFLICT OF INTEREST

The authors declare that there is no conflict of interest regarding the publication of this research work.

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