INTERNATIONAL JOURNAL OF PHARMACEUTICAL SCIENCES
[ISSN: 0975-4725; CODEN(USA): IJPS00]
Journal Homepage: https://www.ijpsjournal.com

OPEN ACCESS

Research Article

Formulation and Standardization of Herbal Sunscreen Lotion

Krunal Sabale*, Mrunali Patil, Sahil Prajapati, Prathamesh Salunkhe, Dr. Bhagyesh Janugade, Shital Jadhav

Krishna Foundation`s Jaywant Institute of Pharmacy, Wathar, Karad, Maharashtra 415539

ARTICLE INFO

Published: 19 May 2026
Keywords:
Herbal sunscreen, Sunscreen lotion formulation, Natural UV protection, Sun Protection Factor (SPF), Herbal cosmetic formulation, Aloe vera extract, Turmeric extract, Rosemary extract, Natural antioxidants, Skin protection, UV radiation protection, Cosmetic standardization, Evaluation parameters, Spreadability
DOI:
10.5281/zenodo.20289222

ABSTRACT

Herbal sunscreen lotions have gained significant attention in recent years due to their safety, eco-friendliness, and reduced side effects compared to synthetic sunscreen agents. The present study focuses on the formulation and standardization of a herbal sunscreen lotion using natural ingredients such as Aloe vera, Rosemary, Turmeric, and Coconut oil along with suitable excipients. The main objective of this research was to develop a stable and effective topical formulation with adequate Sun Protection Factor (SPF) and good cosmetic acceptability. The lotion was prepared using the emulsion method by separately preparing the oil phase and aqueous phase, followed by controlled emulsification. A total of five batches (F1–F5) were formulated and evaluated for various physicochemical and performance parameters including appearance, pH, viscosity, spreadability, homogeneity, washability, irritancy, water resistance, antioxidant activity, and in-vitro SPF determination using UV spectrophotometric method.Among all formulations, batch F3 showed optimum results with desirable SPF value, good stability, and excellent spreadability. The presence of herbal constituents contributed to antioxidant and photoprotective properties.In conclusion, the developed herbal sunscreen lotion demonstrated effective sun protection and can be considered a safe alternative to conventional synthetic formulations.

INTRODUCTION

Sunlight is a vital natural source of energy required for various physiological functions such as vitamin D synthesis; however, excessive exposure to ultraviolet (UV) radiation can lead to severe dermatological disorders. UV radiation is broadly divided into three regions: UVC (100–290 nm), UVB (290–320 nm), and UVA (320–400 nm). While UVC is mostly absorbed by the ozone layer, UVA and UVB penetrate the atmosphere and reach the earth's surface, causing harmful biological effects on human skin [1].

UVB radiation primarily affects the epidermal layer and is responsible for sunburn, erythema, and

***Corresponding Author:** Krunal Sabale
Address: *Krishna Foundation`s Jaywant Institute of Pharmacy, Wathar, Karad, Maharashtra 415539*
Email : krunalsable5439@gmail.com
Relevant conflicts of interest/financial disclosures: The authors declare that the research was conducted in the absence of any commercial or financial relationships that could be construed as a potential conflict of interest.

direct DNA damage, whereas UVA penetrates deeper into the dermis, leading to premature skin aging, oxidative stress, and indirect DNA damage through free radical formation [2]. Continuous and unprotected exposure to these radiations significantly increases the risk of skin malignancies and other chronic skin conditions.

Sunscreens are topical pharmaceutical formulations designed to protect the skin from harmful UV radiation. They act either by absorbing UV rays (chemical sunscreens) or by reflecting and scattering radiation (physical sunscreens) [3]. Despite their effectiveness, synthetic sunscreen agents may cause adverse effects such as skin irritation, allergic reactions, and environmental concerns, which has led to increased interest in herbal and natural alternatives [4].

1.1 Importance of SPF

Sun Protection Factor (SPF) is an internationally accepted parameter used to measure the efficacy of sunscreen products. It is defined as the ratio of the minimal erythemal dose (MED) of protected skin to that of unprotected skin. In simple terms, SPF indicates how long a person can stay in the sun without getting sunburn compared to unprotected exposure [5].

For example, an SPF value of 15 blocks approximately 93% of UVB radiation, SPF 30 blocks about 97%, and SPF 50 blocks nearly 98% of UVB rays. Although higher SPF values provide increased protection, proper application and reapplication are equally important for effectiveness. SPF does not directly measure UVA protection; therefore, broad-spectrum formulations are preferred [6].

1.2 Role of Sunscreen in Preventing Skin Cancer

Skin cancer is one of the most common types of cancer worldwide, and its incidence is increasing due to rising UV exposure. Chronic UV radiation exposure leads to mutations in skin cell DNA, suppression of the immune response, and generation of reactive oxygen species (ROS), all of which contribute to carcinogenesis [7].

Different types of skin cancers associated with UV exposure include:

- Melanoma (most aggressive form)
- Basal cell carcinoma (most common type)
- Squamous cell carcinoma
- Merkel cell carcinoma
- Kaposi sarcoma
- Cutaneous lymphoma
- Actinic keratosis (precancerous lesion)
- Sebaceous carcinoma
- Dermatofibrosarcoma protuberans
- Angiosarcoma

Regular application of sunscreen reduces UV penetration, minimizes DNA damage, and helps prevent the initiation and progression of these cancers. It also plays a crucial role in preventing

photoaging, pigmentation, and immunosuppression of the skin [8].

1.3 Herbal Drugs with Sunscreen Activity

- Herbal ingredients have been widely explored for their photoprotective potential due to the presence of natural antioxidants, flavonoids, phenolic compounds, and vitamins. These constituents help in scavenging free radicals and absorbing UV radiation, thereby providing protection against oxidative damage [9].
- Aloe vera contains aloin, aloe-emodin, vitamins A, C, and E, which exhibit soothing, moisturizing, and UV-protective effects. It also promotes skin healing and reduces inflammation caused by sun exposure [10].
- Rosemary (Rosmarinus officinalis) is rich in rosmarinic acid, carnosic acid, and flavonoids, which possess strong antioxidant properties. These compounds help in neutralizing free radicals and enhancing the photoprotective effect of formulations [11].
- Turmeric (Curcuma longa) contains curcumin, a polyphenolic compound known for its anti-inflammatory, antioxidant, and photoprotective properties. It helps in reducing UV-induced skin damage and prevents oxidative stress [12].
- Coconut oil contains medium-chain fatty acids such as lauric acid, which provide moisturizing effects and a mild natural SPF. It also improves skin barrier function and enhances formulation stability [13].

1.4 Need for Herbal Sunscreen Formulation

The increasing awareness regarding the side effects of synthetic chemicals has shifted the focus toward herbal-based formulations. Herbal sunscreens offer several advantages such as:

- Better safety and skin compatibility
- Reduced risk of irritation and allergies
- Biodegradability and eco-friendliness
- Presence of additional therapeutic benefits such as antioxidant and anti-inflammatory activity

However, challenges such as stability, standardization, and consistency of herbal formulations require systematic scientific evaluation [14].

1.5 Aim and Objectives

Aim:

To formulate and standardize a herbal sunscreen lotion with effective photoprotective activity and good physicochemical stability.

Objectives:

- To develop a stable and cosmetically acceptable herbal sunscreen lotion
- To evaluate SPF using in-vitro methods
- To study physicochemical parameters such as pH, viscosity, and spreadability
- To assess antioxidant activity using DPPH method
- To optimize formulation using different batches (F1–F5)
- To ensure safety through irritancy and stability studies

2. LITERATURE REVIEW

- The incorporation of herbal ingredients into sunscreen formulations has gained significant attention due to their safety, biocompatibility, and minimal adverse effects. Korać R.R. and Khambholja K.M. reported that plant-derived compounds such as flavonoids, phenolic acids, and tannins exhibit strong ultraviolet (UV) absorbing capacity along with potent antioxidant activity. These phytoconstituents play a crucial role in protecting the skin from UV-induced damage by scavenging free radicals and reducing oxidative stress, thereby serving as effective natural alternatives to synthetic sunscreen agents.

- Mishra A.K., Mishra A., and Chattopadhyay P. investigated the role of herbal extracts in sunscreen formulations and concluded that natural ingredients can significantly enhance the Sun Protection Factor (SPF). Their study highlighted that herbal formulations are more compatible with the skin and exhibit fewer side effects compared to synthetic formulations. Additionally, they emphasized that combining multiple herbal agents produces a synergistic effect, leading to improved photoprotective efficiency.

- Surjushe A., Vasani R., and Saple D.G. explored the dermatological applications of Aloe vera and reported that it contains active constituents such as aloin, aloe-emodin, and polysaccharides. These compounds contribute to moisturizing, anti-inflammatory, and wound-healing properties. Their findings demonstrated that Aloe vera improves skin hydration and provides mild UV protection, making it a valuable ingredient in topical formulations.

- Pérez-Fons L., Garzón M.T., and Micol V. studied Rosmarinus officinalis and identified bioactive compounds such as rosmarinic acid and carnosic acid. These constituents exhibit strong antioxidant properties and play a key role in neutralizing reactive oxygen species generated due to UV exposure, thereby enhancing the stability and effectiveness of sunscreen formulations.

- Dutta S., Murthy M.B.R., and Pandit S. evaluated the photoprotective potential of Curcuma longa and reported that curcumin, its major active constituent, possesses potent antioxidant and anti-inflammatory properties. Their study demonstrated that curcumin helps in reducing UV-induced skin damage, preventing lipid peroxidation, and minimizing inflammation, supporting its application in herbal sunscreen formulations.

- Nevin K.G. and Rajamohan T. investigated Coconut oil and found that it contains medium-chain fatty acids such as lauric acid, which enhance skin hydration and barrier function. Their findings concluded that coconut oil acts as an effective emollient, improves spreadability, and contributes to the stability of topical formulations while providing mild UV protection.

- Aulton M.E. explained that emulsion-based systems are widely preferred in topical drug delivery due to their ability to incorporate both hydrophilic and lipophilic substances. Lotion formulations, particularly oil-in-water emulsions, are advantageous because of their non-greasy nature, ease of application, and improved patient compliance, making them ideal for sunscreen preparations.

- Sharma P.P. and co-workers analyzed various herbal cosmetic formulations and observed

that although many herbal ingredients have been studied individually, there is limited research on formulations combining multiple herbal agents with proper standardization. Their findings emphasized the need for systematic evaluation of parameters such as SPF, stability, viscosity, spreadability, and antioxidant activity to ensure the effectiveness and safety of herbal sunscreen products.

Sr. No.	Author(s)	Study Focus	Key Findings	Significance
1	Korać R.R., Khambholja K.M.	Plant-based UV protection	Flavonoids, phenolics, tannins absorb UV and act as antioxidants	Natural alternative to synthetic sunscreens
2	Mishra A.K. et al.	Herbal SPF enhancement	Herbal extracts improve SPF and show synergistic effects	Safer and more effective formulations
3	Surjushe A. et al.	Aloe vera properties	Moisturizing, anti-inflammatory, mild UV protection	Useful in topical skincare formulations
4	Pérez-Fons L. et al.	Rosmarinus officinalis study	Contains rosmarinic & carnosic acid with antioxidant activity	Enhances sunscreen stability and efficacy
5	Dutta S. et al.	Curcuma longa photoprotection	Curcumin reduces UV damage & inflammation	Supports herbal sunscreen use
6	Nevin K.G., Rajamohan T.	Coconut oil properties	Improves hydration, acts as emollient	Enhances spreadability and stability
7	Aulton M.E.	Emulsion systems	Oil-in-water lotions are non-greasy & stable	Ideal for sunscreen formulations
8	Sharma P.P. et al.	Herbal formulation standardization	Need for proper evaluation (SPF, stability, etc.)	Ensures safety and effectiveness

3. MATERIALS AND METHODS

The present study was carried out to formulate and standardize a herbal sunscreen lotion using natural active ingredients along with suitable excipients. The formulation was developed using the emulsion technique and evaluated through various physicochemical and performance parameters.

a. Materials

The materials used in the formulation were of pharmaceutical or analytical grade. Herbal drugs and excipients were selected based on their functional properties in sunscreen formulations.

Active Ingredients (Drugs):

- Aloe vera (soothing, moisturizing, UV protective)
- Rosemary extract (antioxidant, photoprotective)
- Turmeric (anti-inflammatory, antioxidant)

Excipients:

- Coconut oil (emollient, oil phase component)
- Cetyl alcohol (stiffening agent, emulsifier)
- Beeswax (consistency enhancer)
- Phenoxy ethanol (preservative)
- Glycerine (humectant)

- Xanthan gum (viscosity enhancer)
- Vitamin E (antioxidant)
- Rose water (aqueous phase, fragrance)
- Butterfly pea extract (natural colorant, antioxidant)

All the ingredients were procured from reliable sources and used without further purification [23].

b. Formulation Design (Batch Preparation)

Five different batches (F1–F5) were formulated to optimize the composition and achieve the desired characteristics. The concentration of excipients and ratios of oil and aqueous phases were varied in each batch.

Ingredients	F1 (g)	F2 (g)	F3 (g)	F4 (g)	F5 (g)
Aloe vera	1.0	1.2	1.5	1.8	2.0
Rosemary	0.5	0.6	0.8	1.0	1.2
Turmeric	0.05	0.08	0.10	0.12	0.15
Coconut oil	1.5	1.8	2.0	2.2	2.5
Beeswax	1.5	1.8	2.0	2.2	2.5
Cetyl alcohol	0.5	0.7	1.0	1.2	1.5
Glycerine	1.0	1.2	1.5	1.8	2.0
Xanthan gum	0.2	0.3	0.5	0.6	0.7
Vitamin E	0.1	0.15	0.2	0.25	0.3
Rose water	2.0	2.2	2.5	2.8	3.0

3.1 Method of Formulation

The herbal sunscreen lotion was prepared using the emulsion method, which involves the preparation of oil phase and aqueous phase separately followed by emulsification.

Step 1: Oil Phase Preparation

- Take 2 g of beeswax and 2 g of coconut oil in a clean beaker. Heat gently (about 70C) until the beeswax melts completely.
- Add 0.2 g vitamin E oil and 0.1 g turmeric powder to the melted mixture. Stir well [24].

Step 2: Aqueous Phase Preparation

- In another beaker, mix 1.5 g of aloe Vera gel, 1 g of butterfly pea extract, and 2 g of rose water.
- Warm the mixture to the same temperature (Around 70C) to match the oil phase. Emulsification
- Slowly add the warm aqueous phase into the oil phase while stirring continuously.
- Stir for 10-15 minutes using a stirrer and smooth cream forms. Cooling and packaging
- Allow the cream to cool to room temperature.
- Once cooled, transfer the cream into a clean container.
- Store in a cool, dry place away from direct sunlight. [25].

Step 3: Emulsification

The hot aqueous phase was slowly added into the oil phase with continuous stirring. The mixture was stirred for about 10–15 minutes using a mechanical stirrer until a smooth and uniform emulsion was formed. Proper mixing was ensured to avoid phase separation [26].

Step 4: Cooling and Addition of Preservative

The prepared emulsion was allowed to cool gradually to room temperature with continuous stirring. Once the temperature decreased, phenoxy ethanol was added as a preservative and mixed uniformly [27].

Step 5: Packaging

The final lotion was transferred into clean, dry, and airtight containers and stored at room temperature for further evaluation.

3.4 Evaluation Parameters

The prepared formulations were evaluated for various physicochemical and performance

parameters to assess their quality, stability, and effectiveness.

Physicochemical Evaluation

- Appearance (color, odor, texture)
- pH determination
- Homogeneity
- Washability
- Irritancy test

Performance Evaluation

- Spreadability
- Viscosity
- Water resistance
- SPF determination (in-vitro UV spectrophotometric method)

Advanced Evaluation

- Antioxidant activity (DPPH method)
- Stability studies (as per ICH guidelines)

All tests were carried out in triplicate, and the average values were recorded for accuracy and reproducibility [28].

4. RESULTS

The prepared herbal sunscreen lotion formulations (F1–F5) were evaluated for various physicochemical and performance parameters. All the formulations showed acceptable characteristics with slight variations depending on composition. The results obtained from evaluation studies are presented below.

a. Physicochemical Evaluation

All batches were observed for appearance, color, odor, texture, homogeneity, and washability.

Parameter	F1	F2	F3	F4	F5
Appearance	Smooth	Smooth	Smooth	Slightly thick	Thick
Color	Light yellow	Yellow	Yellow	Dark yellow	Dark yellow
Odor	Pleasant	Pleasant	Pleasant	Pleasant	Strong
Texture	Soft	Soft	Creamy	Thick	Very thick
Homogeneity	Good	Good	Excellent	Good	Moderate
Washability	Easy	Easy	Easy	Moderate	Difficult

Observation: All formulations were homogeneous and smooth, but F3 showed the best consistency and texture [29].

b. pH Determination

Batch	pH Value
F1	5.5
F2	6.0
F3	6.5
F4	6.8
F5	5.8

Observation: All formulations were within the acceptable skin pH range (5.5–7), with F3 showing optimal compatibility [30].

5.3 Spreadability

Batch	Spreadability (g·cm/sec)
F1	12
F2	14
F3	18
F4	13
F5	10

Observation: F3 showed maximum spreadability, indicating better application characteristics [31].

5.4 Viscosity

Batch	Viscosity (cP)
F1	1200
F2	1500
F3	1800
F4	2100
F5	2500

Observation: Viscosity increased with increase in wax and thickening agents; F3 showed optimum viscosity [32].

5.5 SPF Determination (In-vitro)

Batch	SPF Value
F1	10
F2	15
F3	25
F4	18
F5	12

Observation: F3 exhibited the highest SPF value, indicating better photoprotective activity [33].

5.6 Water Resistance

Batch	Water Resistance
F1	Moderate
F2	Good
F3	Excellent
F4	Good
F5	Moderate

Observation: F3 showed maximum resistance to water wash-off [34].

5.7 Irritancy Test

All formulations were applied on skin and observed for irritation, redness, or itching.

Result: No irritation or adverse reaction was observed in any batch, indicating safety of formulation [35].

5.8 Antioxidant Activity (DPPH Method)

Batch	% Inhibition
F1	60%
F2	68%
F3	78%
F4	70%
F5	65%

Observation: F3 showed highest antioxidant activity due to optimal concentration of herbal ingredients [36].

5.9 Overall Result Summary

All formulations showed acceptable physicochemical properties

Batch F3 exhibited:

- Highest SPF
- Best spreadability
- Optimal viscosity
- Excellent antioxidant activity
- Good stability and skin compatibility

5. DISCUSSION

The present study was focused on the formulation and evaluation of a herbal sunscreen lotion using natural ingredients. Five batches (F1–F5) were prepared with varying concentrations of excipients and evaluated to determine the optimized formulation. The results obtained from different evaluation parameters were analyzed and interpreted systematically.

All the prepared formulations showed acceptable physicochemical characteristics such as smooth texture, pleasant odor, and good homogeneity. However, slight variations were observed due to differences in composition. Batch F3 exhibited the

most desirable appearance and consistency, which can be attributed to the balanced proportion of oil phase and aqueous phase components [37].

The pH of all formulations was found to be within the acceptable range for topical application (5.5–7), indicating that the formulations are safe and compatible with skin. Batch F3 showed a pH close to neutral skin pH, which minimizes the chances of irritation and enhances user acceptability [38].

Spreadability is an important parameter for topical formulations as it determines ease of application. The results indicated that spreadability increased with an optimal concentration of glycerine and appropriate viscosity. Batch F3 showed maximum spreadability due to its balanced composition, whereas F5 showed reduced spreadability because of higher viscosity [39].

Viscosity plays a crucial role in determining the stability and application properties of the formulation. It was observed that viscosity increased with an increase in beeswax and cetyl alcohol concentration. Although higher viscosity improves stability, excessive viscosity can reduce spreadability. Batch F3 demonstrated optimum viscosity, providing a balance between stability and ease of application [40].

The Sun Protection Factor (SPF) is the most critical parameter in evaluating sunscreen formulations. The SPF values indicated that batch F3 provided the highest protection against UV radiation. This can be attributed to the synergistic effect of herbal ingredients such as Aloe vera, Rosemary, and Turmeric, which possess UV-absorbing and antioxidant properties [41]. Lower SPF values in other batches may be due to insufficient or excessive concentration of active components, affecting the uniformity and effectiveness of the formulation.

Water resistance is another important factor that determines the durability of sunscreen on the skin. Batch F3 showed excellent water resistance, which may be due to the optimal ratio of oil phase components like beeswax and coconut oil. These ingredients help in forming a protective layer on the skin, reducing wash-off [42].

The irritancy test confirmed that all formulations were non-irritant and safe for topical use. This indicates that the selected herbal ingredients and excipients are biocompatible and suitable for skin application [43].

Antioxidant activity, evaluated using the DPPH method, showed that batch F3 had the highest percentage inhibition. This is due to the presence of active phytoconstituents such as curcumin and rosmarinic acid, which effectively neutralize free radicals and protect the skin from oxidative damage [44].

Comparison with Standard Requirements

- pH: Within acceptable skin range (5.5–7) ✓
- SPF: Adequate protection (>15 considered effective) ✓
- Spreadability: Good for topical application ✓
- Viscosity: Optimum for stability and usability ✓
- Irritancy: No irritation observed ✓

Modification in Case of Failure

- Low SPF → Increase concentration of herbal extracts
- High viscosity → Reduce wax or thickening agents

- Poor spreadability → Increase glycerine or reduce viscosity
- Phase separation → Improve emulsification process
- Irritation → Reduce concentration of turmeric or essential oils

Overall, the results indicate that formulation F3 meets the required standards and provides effective photoprotection along with good stability and user acceptability.[45]

6. CONCLUSION

The present study successfully focused on the formulation and standardization of a herbal sunscreen lotion using natural ingredients such as Aloe vera, Rosemary, Turmeric, and Coconut oil. The objective of developing a safe, effective, and stable sunscreen formulation with adequate photoprotective activity was achieved through systematic formulation and evaluation.

A total of five batches (F1–F5) were prepared using different concentrations of excipients, and all formulations were evaluated for physicochemical and performance parameters. The evaluation results demonstrated that all batches exhibited acceptable properties such as suitable pH, good homogeneity, non-irritant nature, and satisfactory spreadability.

Among all the batches, formulation F3 was found to be the optimized formulation as it showed the most desirable characteristics, including optimum viscosity, excellent spreadability, good water resistance, and the highest Sun Protection Factor (SPF). The enhanced performance of F3 can be attributed to the balanced ratio of oil and aqueous phases along with the synergistic effect of herbal ingredients.

The presence of natural antioxidants such as curcumin and rosmarinic acid contributed significantly to the antioxidant activity and photoprotective effect of the formulation. The lotion also exhibited good stability and skin compatibility, indicating its suitability for topical application without causing irritation or adverse effects.

Furthermore, the study highlights the potential of herbal ingredients as effective alternatives to synthetic sunscreen agents. Herbal formulations not only provide protection against harmful UV radiation but also offer additional benefits such as moisturizing, anti-inflammatory, and antioxidant effects.

In conclusion, the developed herbal sunscreen lotion can be considered a promising, safe, and eco-friendly formulation for skin protection. Future studies can be carried out to enhance SPF further, perform in-vivo evaluations, and scale up the formulation for commercial applications.

REFERENCES

1. Korać, R. R., & Khambholja, K. M. (2011). Potential of herbs in skin protection from ultraviolet radiation. Pharmacognosy Reviews, 5(10), 164–173.
2. Mishra, A. K., Mishra, A., & Chattopadhyay, P. (2011). Herbal cosmeceuticals for photoprotection from ultraviolet B radiation: A review. Tropical Journal of Pharmaceutical Research, 10(3), 351–360.
3. Surjushe, A., Vasani, R., & Saple, D. G. (2008). Aloe vera: A short review. Indian Journal of Dermatology, 53(4), 163–166.
4. Pérez-Fons, L., Garzón, M. T., & Micol, V. (2010). Relationship between the antioxidant capacity and effect of rosemary (Rosmarinus officinalis L.) polyphenols on membrane

phospholipid order. Journal of Agricultural and Food Chemistry, 58(1), 161–171.
5. Dutta, S., Murthy, M. B. R., & Pandit, S. (2012). Curcumin: A potential therapeutic agent in skin disorders. International Journal of Pharmaceutical Sciences Review and Research, 15(2), 47–52.
6. Nevin, K. G., & Rajamohan, T. (2010). Effect of topical application of virgin coconut oil on skin components and antioxidant status. Food and Chemical Toxicology, 48(8–9), 2478–2483.
7. Aulton, M. E. (2018). Aulton's Pharmaceutics: The Design and Manufacture of Medicines (5th ed.). Elsevier.
8. Sharma, P. P. (2015). Cosmetics: Formulation, Manufacturing and Quality Control (5th ed.). Vandana Publications.
9. Diffey, B. L. (2001). Sunscreens and UVA protection: A major issue of minor importance. Photochemical & Photobiological Sciences, 76(1), 1–3.
10. Sayre, R. M., Agin, P. P., LeVee, G. J., & Marlowe, E. (1979). A comparison of in vivo and in vitro testing of sunscreening formulas. Photochemistry and Photobiology, 29(3), 559–566.
11. Mansur, J. S., Breder, M. N. R., Mansur, M. C. A., & Azulay, R. D. (1986). Determination of sun protection factor by spectrophotometry. Anais Brasileiros de Dermatologia, 61, 121–124.
12. Pathak, M. A. (2003). Sunscreens: Progress and perspectives on photoprotection of human skin against ultraviolet radiation. Journal of Dermatology, 30(3), 231–240.
13. Barel, A. O., Paye, M., & Maibach, H. I. (2014). Handbook of Cosmetic Science and Technology (4th ed.). CRC Press.
14. Kapoor, V. P. (2005). Herbal cosmetics for skin and hair care. Natural Product Radiance, 4(4), 306–314.
15. Rastogi, R. P., Richa, Kumar, A., Tyagi, M. B., & Sinha, R. P. (2010). Molecular mechanisms of ultraviolet radiation-induced DNA damage and repair. Journal of Nucleic Acids, 2010, 1–32.
16. Mishra, V., Bansal, M., & Tiwari, R. (2014). Formulation and evaluation of herbal sunscreen lotion. International Journal of Pharmaceutical Sciences and Research, 5(3), 1234–1240.
17. Kaur, C. D., & Saraf, S. (2010). In vitro sun protection factor determination of herbal oils used in cosmetics. Pharmacognosy Research, 2(1), 22–25.
18. Singh, M., Sharma, R., & Gupta, A. (2012). Evaluation of herbal sunscreen formulations. International Journal of Cosmetic Science, 34(3), 234–240.
19. Agrawal, S., & Dubey, S. (2015). Development and evaluation of herbal sunscreen cream. Journal of Drug Delivery and Therapeutics, 5(2), 45–50.
20. Joshi, H., & Parle, M. (2006). Development and evaluation of herbal cosmetic cream. International Journal of Green Pharmacy, 1(2), 78–82.
21. Patil, S., & Patel, N. (2017). Formulation and evaluation of topical herbal formulations. Asian Journal of Pharmaceutical Research, 7(4), 200–206.
22. Gupta, R., & Jain, S. (2018). Herbal sunscreen: A review on natural photoprotective agents. International Journal of Pharmaceutical Sciences Review and Research, 49(1), 67–73.
23. ICH Harmonised Tripartite Guideline. (2003). Stability testing of new drug substances and products (Q1A(R2)). International Conference on Harmonisation.
24. USP, United Stated Pharmacopeia. "791> pH, USP 43-NF 38. United States pharmacopeial

convention." Inc.: Online version (2020): 7022.

25. Ospanova, S. I., Zhumashova, G. T., Sakipova, Z. B., Tulegenova, A. U., An, V. S., Suleimenov, M. K., ... & Salykbayev, A. A. (2025). Comparative Analysis of Pharmacopoeia Requirements to Medicinal Plant Raw Materials of the Genus Iris L. West Kazakhstan Medical Journal, 67(3), 298-309.
26. Sah, B. K., Ahmad, F., Kumar, A., Singh, S. K., & Sachdeva, R. K. (2025). Catering the Need of Drug Manufacturing Standard in India: An Update to Indian Pharmacopoeia. Therapeutic Innovation & Regulatory Science, 59(3), 471-488.
27. Bhatia, S. (2016). Nanoparticles types, classification, characterization, fabrication methods and drug delivery applications. In Natural polymer drug delivery systems: Nanoparticles, plants, and algae (pp. 33-93). Cham: Springer International Publishing.
28. Lachman, L., Lieberman, H. A., & Kanig, J. L. (2009). The Theory and Practice of Industrial Pharmacy (3rd ed.). CBS Publishers.
29. Allen, L. V. (2013). Pharmaceutical Dosage Forms and Drug Delivery Systems (10th ed.). Lippincott Williams & Wilkins.
30. Williams, A. (2003). Transdermal and topical drug delivery from theory to clinical practice. Pharmaceutical press.
31. Florence, A. T., & Attwood, D. (2015). Physicochemical Principles of Pharmacy (6th ed.). Pharmaceutical Press.
32. Rawlins, E. A. (1977). Bentley's Textbook of Pharmaceutics, 8th. The English Language Book Society and Bailliere Tindall, London, 647-650.
33. Ansel, H. C., Allen, L. V., & Popovich, N. G. (2011). Pharmaceutical Dosage Forms and Drug Delivery Systems (9th ed.). Lippincott.
34. Hadgraft, J., & Lane, M. E. (2005). Skin permeation: The years of enlightenment. International Journal of Pharmaceutics, 305(1–2), 2–12.
35. OECD. (2015). Guidelines for the testing of chemicals: Skin irritation/corrosion. Organisation for Economic Co-operation and Development.
36. OECD. (2019). Test No. 439: In vitro skin irritation reconstructed human epidermis test method.
37. Blois, M. S. (1958). Antioxidant determinations by the use of a stable free radical. Nature, 181, 1199–1200.
38. Brand-Williams, W., Cuvelier, M. E., & Berset, C. (1995). Use of a free radical method to evaluate antioxidant activity. LWT – Food Science and Technology, 28(1), 25–30.
39. Diffey, B. L. (2002). Sources and measurement of ultraviolet radiation. Methods, 28(1), 4–13.
40. Pathak, M. A., & Fitzpatrick, T. B. (1993). The evolution of photoprotection. Journal of Photochemistry and Photobiology B, 20(2–3), 91–95.
41. Young, A. R. (2006). Acute effects of UV radiation on the skin. Progress in Biophysics and Molecular Biology, 92(1), 80–85.
42. Narayanan, D. L., Saladi, R. N., & Fox, J. L. (2010). Ultraviolet radiation and skin cancer. International Journal of Dermatology, 49(9), 978–986.
43. Nichols, J. A., & Katiyar, S. K. (2010). Skin photoprotection by natural polyphenols. Archives of Dermatological Research, 302(2), 71–83.
44. Kokate, C. K., Purohit, A. P., & Gokhale, S. B. (2010). Pharmacognosy (49th ed.). Nirali Prakashan.

HOW TO CITE: Krunal Sabale, Mrunali Patil, Sahil Prajapati, Prathamesh Salunkhe, Dr. Bhagyesh Janugade, Shital Jadhav, Formulation and Standardization of Herbal Sunscreen Lotion, Int. J. of Pharm. Sci., 2026, Vol 4, Issue 5, 5020-5033. https://doi.org/10.5281/zenodo.20289222