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Research Article

Formulation and Evaluation of Sunscreen for Photoprotection

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ABSTRACT

Sunscreens play a crucial role in protecting human skin from the harmful effects of ultraviolet (UV) radiation. UV exposure is a major contributing factor to premature skin aging, hyperpigmentation, immune suppression, and an increased risk of skin cancer. The formulation of an effective sunscreen requires a careful selection of active and functional ingredients that provide broad-spectrum protection while maintaining skin compatibility and stability. This research focuses on the development and evaluation of a sunscreen formulation incorporating both organic and inorganic UV filters to ensure maximum efficacy. The formulation includes titanium dioxide, a well-known inorganic physical filter that reflects and scatters UV radiation, and additional stabilizing and skin-enhancing components such as ethylenediaminetetraacetic acid (EDTA), triglycerides, carbopol 40, and vitamin A. EDTA serves as a chelating agent, preventing oxidative degradation and enhancing formulation stability, while triglycerides contribute to the skin's hydration and smooth application. Carbopol 40 functions as a thickening agent, ensuring optimal consistency and ease of application. The inclusion of vitamin A provides additional skin benefits by supporting cellular regeneration and offering antioxidant protection. Various physicochemical tests and in vitro SPF determination, were conducted to assess the efficacy of the formulation. Spread ability and sensory evaluation confirmed the formulation's user-friendliness. The results indicate that the optimized formulation offers significant UV protection, good stability, and excellent skin compatibility, making it a potential candidate for commercial application.

INTRODUCTION

Exposure to ultraviolet (UV) radiation from the sun is a major concern due to its adverse effects on human skin. (1) UV rays contribute to premature skin aging, hyperpigmentation, and severe health issues such as skin cancer. Factors such as ozone layer depletion, increased outdoor activities, and changing climate conditions have heightened the risk of UV-induced (2) skin damage, emphasizing the necessity of effective photoprotection. The

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human skin acts as a natural barrier against environmental hazards, including UV radiation. However, prolonged exposure can lead to acute effects such as erythema (redness), sunburn, and DNA damage, while chronic exposure can result in (3) photoaging, loss of skin elasticity, and increased risk of melanoma and basal cell carcinoma. Sunscreens serve as a crucial protective measure by incorporating active ingredients that either absorb or reflect UV radiation, mitigating its harmful effects. In modern sunscreen formulations, a combination of physical and chemical UV filters is used to achieve broad-spectrum protection. Titanium dioxide, an inorganic UV filter, functions by reflecting and scattering UV rays, making it highly effective in preventing skin penetration. (4) Additionally, stabilizers such as ethylenediaminetetraacetic acid (EDTA) are incorporated to enhance the formulation's longevity by preventing oxidative degradation. Moisturizing agents like triglycerides help maintain skin hydration, ensuring a non-drying and comfortable application. Carbopol 40, a thickening and emulsifying agent, improves the consistency and spread ability of the sunscreen, while Vitamin A (retinol) plays a vital role in skin regeneration and provides antioxidant benefits that help combat oxidative stress caused by UV exposure. These components collectively contribute to an effective sunscreen formulation that not only protects against UV damage but also nourishes and improves skin health (5) .

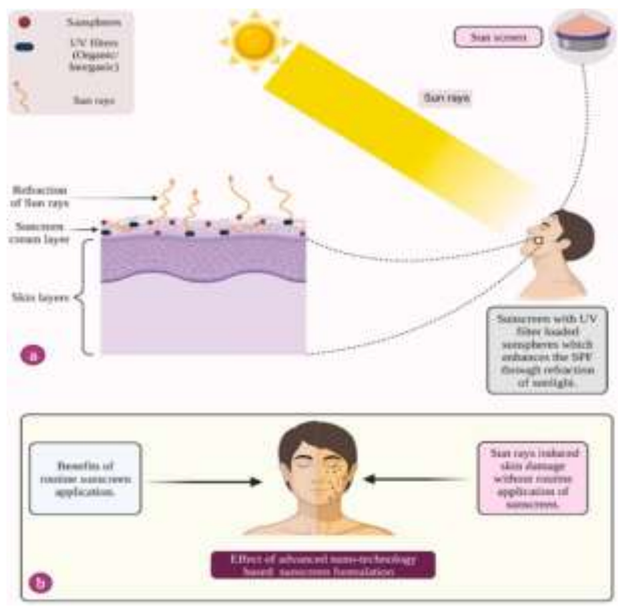

Fig1: Harmful effects of UV radiations

Evolution of Sunscreens

The concept of sun protection dates back to ancient civilizations, where natural ingredients such as rice bran, jasmine extracts, and zinc-based pastes were used to shield the skin from excessive sun exposure. Over time, scientific advancements led to the development of modern sunscreens with enhanced UV protection properties. The first commercial sunscreen was introduced in the 1930s, primarily containing para-aminobenzoic acid (PABA) as a UVB filter. However, concerns regarding PABA's potential to cause allergic reactions and skin irritation led to the development of alternative UV filters. The 1980s and 1990s saw the introduction of broad-spectrum sunscreens, which provided both UVA and UVB protection, using a combination of organic and inorganic filters. The inclusion of antioxidants, stabilizers, and moisturizing agents further improved sunscreen efficacy and (6) cosmetic appeal. Today, sunscreens are categorized based on their sun protection factor (SPF), water resistance, and formulation type—whether they utilize chemical filters, such as oxybenzone and avobenzone, or physical filters, such as titanium dioxide and zinc oxide. The incorporation of additional active ingredients, such as vitamin A and triglycerides, has allowed sunscreen formulations to offer skincare benefits beyond UV protection, including hydration, anti-aging, and enhanced skin repair. The continuous evolution of sunscreen technology aims to develop multifunctional products that provide superior photoprotection while maintaining user comfort and skin compatibility (7).

Current Trends in Sunscreen Formulation

Recent advancements in sunscreen formulation focus on improving efficacy, safety, and environmental sustainability (8). The demand for next-generation sunscreens that not only protect against UV radiation but also offer additional skin benefits has driven innovation in the industry. One of the emerging trends is the development of reef-safe sunscreens, which exclude harmful chemicals like oxybenzone and octinoxate that contribute to coral bleaching. Instead, formulators are utilizing safer alternatives such as titanium dioxide and zinc oxide in non-nano forms to ensure environmental compatibility without compromising protection (9). Nanotechnology has also played a crucial role in modern sunscreen formulations, enhancing the transparency and effectiveness of physical UV filters. Traditional mineral sunscreens often left a white cast on the skin due to larger particle sizes; however, the use of nano-sized titanium dioxide and zinc oxide has significantly improved their cosmetic appeal, making them suitable for everyday wear. Furthermore, stabilizing agents such as EDTA are being incorporated to prolong the shelf life of sunscreen formulations and prevent the degradation of active ingredients. Carbopol-based gels have gained popularity due to their lightweight and non-greasy texture, making sunscreen application more comfortable, especially for individuals with oily or acne-prone skin. Another significant trend is the integration of skincare ingredients into sunscreen formulations. Vitamin A (retinol) is widely used for its ability to promote skin cell turnover and reduce signs of aging, while triglycerides contribute to long-lasting hydration and improved skin barrier function. This shift toward multifunctional sunscreen products ensures that users receive both sun protection and enhanced skincare benefits in a single formulation (10).

Challenges in Sunscreen Development

Despite significant advancements, sunscreen formulation presents several challenges. Achieving a balance between broad-spectrum UV protection, cosmetic appeal, and formulation stability is complex. Physical filters like titanium dioxide may cause whitening effects, requiring modification through nanotechnology. Chemical filters, though effective, have raised concerns regarding potential skin irritation and environmental toxicity (11). Another challenge is ensuring photostability, where active ingredients do not degrade upon sun exposure. Stabilizers such as EDTA help enhance sunscreen longevity, but additional measures such as encapsulation of UV filters are being explored. Additionally, regulatory compliance varies by region, affecting ingredient selection and product approval. Water resistance is another critical factor, particularly for outdoor activities. Formulations must be designed to maintain efficacy despite exposure to water and sweat. Innovations such as film-forming polymers and enhanced emulsification techniques are being developed to address this issue. Given these innovations and challenges, this study aims to develop and evaluate a sunscreen formulation that balances high UV protection, optimal spread ability, long-term stability, and skin compatibility while incorporating the latest advancements in sunscreen technology. By utilizing a combination of physical UV filters, stabilizers, and skincare-enhancing ingredients, this research seeks to contribute to the ongoing development of safer, more effective, and environmentally responsible sunscreen products.

Overview of Sunscreen Mechanisms

Sunscreens work primarily through the incorporation of physical and chemical UV filters that protect the skin from ultraviolet radiation. Physical filters, such as titanium dioxide and zinc oxide, function by reflecting and scattering UV rays, preventing them from penetrating the skin. These filters are especially effective against both UVA and UVB rays, offering broad-spectrum protection. On the other hand, chemical UV filters, including oxybenzone, avobenzone, and octinoxate, absorb UV radiation and convert it into harmless heat energy, preventing DNA damage. However, chemical filters have raised concerns regarding skin irritation and environmental toxicity, leading to increased interest in hybrid formulations that combine both physical and chemical filters for enhanced efficacy and safety. Additionally, antioxidants such as vitamin A (retinol), vitamin C, (12) and vitamin E play a critical role in neutralizing free radicals generated by UV exposure, preventing oxidative stress and reducing the risk of premature aging and skin cancer. EDTA (ethylenediaminetetraacetic acid) is often incorporated in sunscreen formulations to act as a stabilizer, preventing oxidative degradation of active ingredients and ensuring a longer shelf life.

Advances in Sunscreen Formulation

Significant advancements in sunscreen formulations have been made to improve efficacy, cosmetic appeal, and environmental sustainability. Some of the key innovations include:

Nanotechnology in Sunscreens: The development of nano-sized titanium dioxide and zinc oxide has improved the transparency and spreadability of physical sunscreens. While traditional formulations left a visible white cast, nano-formulations provide a clear and lightweight application, making them more suitable for daily use. However, concerns about nanoparticle penetration and environmental effects have led to ongoing regulatory scrutiny. (13)

Multifunctional Sunscreens: Modern formulations integrate skincare benefits alongside UV protection. Ingredients like triglycerides offer hydration, while carbopol 40 ensures a smooth, gel-like consistency for easy application. Additionally, the inclusion of anti-aging components such as retinol (Vitamin A) enhances collagen production and reduces fine lines and wrinkles, making sunscreens more appealing to consumers.

Water-Resistant and Sweat-Resistant Technologies: Recent developments have focused on improving the durability of sunscreens in water and sweat conditions. Film-forming polymers are incorporated to ensure that UV protection remains intact even after swimming or heavy perspiration. These formulations are essential for sports and outdoor activities, ensuring long-lasting protection.

Eco-Friendly and Reef-Safe Sunscreens: With increasing awareness of environmental concerns, the industry has shifted towards reef-safe formulations that exclude harmful chemicals like oxybenzone and octinoxate (14), which have been linked to coral bleaching. Titanium dioxide and zinc oxide, when used in non-nano form, are considered safer alternatives.

Photostability of Sunscreens

Photo stability refers to the ability of sunscreen ingredients to remain effective upon exposure to sunlight. Some UV filters degrade over time, reducing their protective capabilities and generating free radicals that may harm the skin. Titanium dioxide and zinc oxide are highly photostable and do not degrade significantly under UV exposure, making them ideal for long-lasting protection (15). However, certain chemical UV filters such as avobenzone require stabilizers like EDTA or pairing with more photostable ingredients to prevent breakdown. The incorporation of antioxidants such as vitamin A and vitamin E further enhances photostability by neutralizing free radicals and preventing oxidative damage. Recent innovations focus on encapsulation techniques to improve the photostability of sunscreens, thereby extending their protective efficacy.

Role of Emollients and Stabilizers in Sunscreen Formulations

Emollients and stabilizers are critical in determining the texture, spread ability, and durability of sunscreens. Triglycerides act as emollients, ensuring that the formulation remains hydrating and prevents dryness caused by UV exposure. Carbopol 40 functions as a stabilizer, improving the viscosity and consistency of the product while maintaining uniform dispersion of active ingredients. Additionally, EDTA is commonly used to prevent metal ion contamination and oxidative degradation, thereby enhancing the shelf life and stability of the formulation. These components work synergistically to ensure that sunscreen products provide long-lasting protection with an elegant feel upon application.

Challenges and Future Directions in Sunscreen Development

Despite advancements, sunscreen formulations continue to face challenges, including:

Consumer Preferences and Cosmetic Appeal: Many consumers prefer lightweight, non-greasy, and fast-absorbing sunscreens, which poses a challenge in balancing efficacy with aesthetics. Research is ongoing to develop non-whitening formulations without compromising on protection.

Environmental Concerns: The impact of chemical sunscreens on marine ecosystems has led to stringent regulations and bans. Future research is focused on developing biodegradable, reef-safe formulations that provide effective UV protection without harming the environment (16).

Ingredient Safety and Regulations: The safety of certain chemical filters remains under review, necessitating continuous testing and adaptation to regulatory changes. The development of novel UV filters with better safety profiles is a key area of interest (17).

Enhanced Skin Benefits: The incorporation of anti-aging, anti-inflammatory, and hydrating properties in sunscreens continues to evolve, with innovations in peptide-based formulations, botanical extracts, and microbiome-friendly UV filters.

MATERIALS AND METHODS

Materials

The sunscreen formulation was developed using the following ingredients:

Distilled Water: Used as a solvent for the aqueous phase and ensures purity in the formulation. Ethylenediaminetetraacetic Acid (EDTA): Acts as a stabilizer to prevent oxidation and metal ion contamination, ensuring the longevity of the product.

Glycerine: Functions as a humectant to retain moisture and improve hydration, preventing excessive dryness upon application.

Titanium Dioxide: Serves as a physical UV filter, providing broad-spectrum protection by reflecting and scattering UV rays (18). It is especially effective in shielding against both UVA and UVB radiation.

Triglyceride: Enhances the emollient properties of the sunscreen, making it more moisturizing and improving skin feel. It also contributes to the spread-ability of the formulation, ensuring an even application.

Carbopol 40: A thickening agent that helps in stabilizing the formulation and maintaining a smooth texture. It provides a gel-like consistency, improving the usability of the sunscreen.

Benzyl Alcohol: Acts as a preservative to prevent microbial contamination and enhance the product's shelf life.

Vitamin A (Retinol): Provides antioxidant benefits, promotes skin regeneration, and enhances anti-aging properties. It also helps repair UV-induced skin damage and improves skin elasticity (19).

Rose Water: Offers soothing and anti-inflammatory properties while contributing to the fragrance of the sunscreen. It also provides mild astringent effects, making the sunscreen more refreshing on application (20).

Formula Used: The table 1 shows the ingredients used along with their quantity.

Table 1: Sunscreen formula

INGREDIENTS	PERCENTAGE%	CATEGORY
Distilled Water	63%	Solvent
Glycerine	7%	Thickening Agent
EDTA	0.3%	Chelating Agent
Titanium Dioxide	6%	Physical UV Filter
Triglyceride	10%	Moisturizing agent
Carbopol - 40	12%	Emulsifier
Vitamin - A	0.1%	Anti-ageing
Benzyl Alcohol	0.1%	Preservative
Rose Water	1.5%	Fragrance

METHOD

The sunscreen was prepared using a three-phase emulsification process, which included the preparation of the oil phase, aqueous phase, and final emulsification.

Step 1: Preparation of the Oil Phase

Triglyceride and titanium dioxide were accurately weighed and transferred into a clean, dry beaker. The two components were mixed thoroughly to ensure even dispersion of the titanium dioxide particles in the lipid base. Benzyl alcohol was added to the mixture to act as a preservative and maintain microbial stability. The entire phase was heated to approximately 70°C while continuously stirring with a mechanical stirrer to ensure uniform dispersion of all components.

Step 2: Preparation of the Aqueous Phase

A separate beaker was filled with distilled water and heated to 70°C. EDTA was added to the water and stirred until fully dissolved to ensure metal ion sequestration and stability of active ingredients. Glycerine was slowly incorporated into the mixture to enhance the moisturizing properties of the formulation. Carbopol 40 was sprinkled gradually into the aqueous phase while stirring vigorously to prevent clumping and ensure uniform dispersion. Rose water was added to the mixture for its soothing effects and to provide a pleasant sensory experience.

Step 3: Emulsification Process

The oil phase was slowly introduced into the aqueous phase while continuously stirring at high speed using a homogenizer to form a stable emulsion. The emulsion was homogenized for at least 15-20 minutes to ensure complete integration of the oil and water phases. After emulsification, the mixture was allowed to cool down to approximately 40°C before adding vitamin A to prevent its degradation due to heat. The final formulation was mixed thoroughly using a slow-speed stirrer to remove any air bubbles and improve texture. The prepared sunscreen was then transferred into sterile containers and allowed to settle at room temperature before further analysis.

Fig 2: Oil phase and Aqueous phase

Evaluation of sunscreen

To ensure the effectiveness and stability of the formulated sunscreen, several evaluation tests were conducted:

SPF Determination

The Sun Protection Factor (SPF) was measured using in vitro spectrophotometric analysis. Absorbance of Hydrochloric Solution of formulation was taken at different wavelength ranging from 290-320nm and SPF was calculated.

Spreadability Test

Spreadability was evaluated by placing a fixed amount of sunscreen between two glass slides.
A standard weight was placed over the top slide, and the diameter of the spread formulation was measured.
The formula for calculating it is :

Spreadability: $S = M \times L / t$

Where, M = weight tied to the upper slide
L = length of glass slide
T = time taken to separate the slides

A higher spreadability value indicates easier application and uniform coverage.

Physical Parameter Analysis

The sunscreen was assessed for colour, texture, and homogeneity by visual inspection. Any phase separation, sedimentation, or graininess was noted to ensure a stable and smooth formulation.

pH Determination

The pH level of the sunscreen was measured using a digital pH meter to ensure skin compatibility. The target pH range was 5.5-7.0, suitable for human skin.

Viscosity Measurement

A Brookfield Viscometer was used to determine the viscosity of the sunscreen. The consistency was checked to ensure the formulation was neither too runny nor too thick.

Washability Test

A measured amount of sunscreen was applied to a glass slide and rinsed with water. The extent of removal was evaluated to determine water resistance.

Homogeneity Assessment

A small quantity of the sunscreen was spread over a glass plate. The formulation was checked for uniformity, ensuring no lumps or phase separation.

Irritancy Test

Mark an area (one sq. cm) on the left hand dorsal surface. The lotion was applied to the specified area and time was noted. Irritancy, erythema, edema was checked if any for regular interval up to 24 hrs and reported.

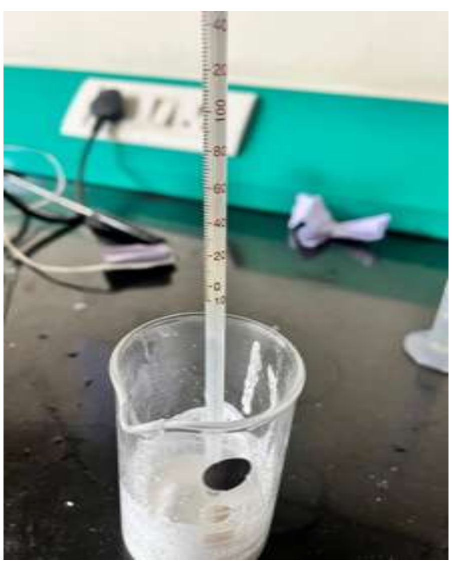

Fig 3 A: Temperature measurement while mixing oily and aqueous phases

Fig 3 B: pH determination

RESULTS AND DISCUSSION

The sunscreen formulation developed in this study underwent several evaluations to assess its effectiveness and user compatibility. One of the most important findings was the SPF value of 24, which confirmed the product's ability to offer strong protection against harmful UV rays. Titanium dioxide, acting as a physical blocker, played a major role in this, helping to reflect and scatter UV radiation across both UVA and UVB spectrums. In terms of application, the formulation showed excellent spreadability. It applied smoothly and evenly on the skin without requiring much effort. This can largely be attributed to the presence of triglycerides and glycerine

$$\text{Spreadability: } S = M \times L / t$$

Where, M = 5g, L = 7.5cm, T = 10 sec
Spreadability value came out to be 3.75 g cm/s.
From a visual and sensory standpoint, the sunscreen had a clean, consistent appearance with White colour observed. It didn't separate or develop any lumps. The odour of formulation was checked by applying on hand and spreading. The subtle fragrance from the rose water gave it a pleasant fragrance. The pH level was within the ideal range for human skin that is 7.0, which is a

good indication that the product is unlikely to cause irritation or disrupt the skin's natural barrier. For irritancy when the lotion was applied on marked surface on hand and left for 24 hours it didn't showed any irritation or redness. The washability test revealed that the sunscreen has moderate resistance to water, carried out by simply washing applied sunscreen lotion with water. Homogeneity was another important factor examined during evaluation. The cream was uniform throughout, with no visible separation or granules, by visual appearance and touch. Altogether, the results of these evaluations suggest that the sunscreen not only performs well in terms of photoprotection but also offers a user-friendly and skin-compatible experience. These findings support the formulation's potential for further development and commercial use.

CONCLUSION

The present study successfully formulated and evaluated a sunscreen designed to offer broad-spectrum protection against ultraviolet radiation, while also enhancing skin hydration and overall dermatological health. By integrating both physical and functional ingredients — notably titanium dioxide, EDTA, glycerine, triglycerides, carbopol 40, vitamin A, and rose water — the formulation achieved a balanced synergy of photoprotection, cosmetic elegance, and skin compatibility. Comprehensive in vitro evaluations demonstrated that the sunscreen possesses a high Sun Protection Factor (SPF), primarily due to the inclusion of titanium dioxide, which reflects and scatters both UVA and UVB rays. The formulation exhibited excellent spreadability, desirable viscosity, and stable physical characteristics such as smooth texture, homogeneity, and a skin-friendly pH. Sensory assessments further confirmed its appeal in terms of fragrance and ease of application. Importantly, the product showed moderate washability, making it resilient under routine exposure to sweat or brief water contact, while also encouraging reapplication for sustained protection. The absence of irritation during patch testing confirmed its safety profile, suggesting suitability for regular use on a range of skin types. Overall, this research underscores the feasibility of creating an effective, user-friendly sunscreen using a thoughtful selection of both traditional and supportive cosmetic ingredients. The successful performance of the formulation in laboratory tests indicates its potential as a viable candidate for commercial development. Future studies are recommended to include long-term in vivo assessments, stability, scalability trials, and the integration of natural botanical antioxidants to further enhance protective and therapeutic benefits. Such advancements may not only improve efficacy but also align the product with growing consumer demand for natural and multifunctional skincare solutions.

Table 2: List of abbreviation

Sr. No.	Abbreviation	Full form
1	UV	Ultra-Violet
2	EDTA	Ethylene Diamine Tetra Acetic Acid
3	SPF	Sun Protection factor
4	DNA	Deoxy-ribonucleic Acid
5	PABA	Para Amino-benzoic acid
6	C	Celsius
7	pH	Potential of Hydrogen

REFERENCES

1. Gohil, P., & Patel, B. (2019). Sunscreen formulation and evaluation: A review. Journal of Drug Delivery and Therapeutics, 9(2), 490–496. https://doi.org/10.22270/jddt.v9i2.2454.
2. Mancebo, S. E., Hu, J. Y., & Wang, S. Q. (2014). Sunscreens: A review of health, safety, and regulatory issues. Dermatologic Clinics, 32(3), 427–438. https://doi.org/10.1016/j.det.2014.03.010

3. Pinnell, S. R. (2003). Cutaneous photodamage, oxidative stress, and topical antioxidant protection. Journal of the American Academy of Dermatology, 48(1), 1–19. https://doi.org/10.1067/mjd.2003.35
4. Nguyen, V. B., Nguyen, T. T. T., & Pham, V. N. T. (2024). Formulation and SPF evaluation of physical sunscreen containing titanium dioxide and zinc oxide. Tra Vinh University Journal of Science, 14(2). https://journal.tvu.edu.vn/index.php/journal/article/view/3790.
5. Moyano, M. A., & Segall, A. I. (2011). Stability study of vitamin A palmitate in the presence of vitamin E and other antioxidants. Latin American Journal of Pharmacy, 30(1), 85–90.
6. Couteau, C., Faure, A., & Coiffard, L. J. M. (2007). Study of the photostability of 18 sunscreens in creams by measuring the SPF in vitro. Journal of Pharmaceutical and Biomedical Analysis, 44(1), 270–273. https://doi.org/10.1016/j.jpba.2007.01.052
7. Serpone, N., Dondi, D., & Albini, A. (2007). Inorganic and organic UV filters: Their role and efficacy in sunscreens and suncare products. Inorganica Chimica Acta, 360(3), 794–802. https://doi.org/10.1016/j.ica.2006.07.073
8. Gasparro, F. P., Mitchnick, M., & Nash, J. F. (1998). A review of sunscreen safety and efficacy. Photochemistry and Photobiology, 68(3), 243–256. https://doi.org/10.1111/j.1751-1097.1998.tb09680.x
9. Rehman, M. U., Akash, M. S. H., & Alvi, A. Z. (2014). Sunscreen: A review. Journal of Pharmaceutical and Biological Sciences, 2(4), 50–58.
10. Fraj, A. L., Brandelli, A., & Marczak, L. D. F. (2019). In vitro release of vitamins C and E from microcapsules stabilized by gelatin-sodium caseinate system in double W/O/W emulsions. Food Research International, 121, 542–549. https://doi.org/10.1016/j.foodres.2018.12.017
11. Afaq, F., & Mukhtar, H. (2006). Botanical antioxidants in the prevention of photocarcinogenesis and photoaging. Experimental Dermatology, 15(9), 678–684. https://doi.org/10.1111/j.1600-0625.2006.00466.x
12. Maia Campos, P. M. B. G., Gaspar, L. R., & Gonçalves, G. M. S. (2006). In vitro antioxidant activity and in vivo efficacy of topical formulations containing vitamin C and its derivatives studied by non-invasive methods. Skin Research and Technology, 12(2), 99–107. https://doi.org/10.1111/j.0909-752X.2006.00145.x
13. Lahari, P., & Ratnamala, K. V. (2021). Formulation development and evaluation of sunscreen. International Journal of Innovative Research in Technology, 8(1), 86–94
14. Gonzalez, H., Farbrot, A., Larko, O., & Wennberg, A. M. (2007). Percutaneous absorption of the sunscreen benzophenone-3 after repeated whole-body applications, with and without ultraviolet irradiation. British Journal of Dermatology, 156(2), 217–219. https://doi.org/10.1111/j.1365-2133.2006.07628.x
15. Jansen, R., Osterwalder, U., & Wang, S. Q. (2013). Photoprotection: Part I. Photoprotection by naturally occurring, physical, and systemic agents. Journal of the American Academy of Dermatology, 69(6), 853.e1–853.e12. https://doi.org/10.1016/j.jaad.2013.06.032
16. Draelos, Z. D. (2007). The efficacy of sunscreen ingredients in preventing UV-induced skin damage. Journal of Cosmetic Dermatology, 6(1), 2–9.

https://doi.org/10.1111/j.1473-2165.2007.00302.x

17. Kockler, J., Oelgemöller, M., Robertson, S., & Glass, B. D. (2012). Photostability of sunscreens. Journal of Photochemistry and Photobiology C: Photochemistry Reviews, 13(1), 91–110. https://doi.org/10.1016/j.jphotochemrev.2011.12.001
18. Kockler, J., Oelgemöller, M., Robertson, S., & Glass, B. D. (2012). Photostability of sunscreens. Journal of Photochemistry and Photobiology C: Photochemistry Reviews, 13(1), 91–110. https://doi.org/10.1016/j.jphotochemrev.2011.12.001
19. Goswamcosmetici, P. K., & Naik, S. N. (2014). Natural sunscreen agents: A review. Scholars Academic Journal of Pharmacy, 3(6), 461–468.
20. Abidi, S., Shaheen, N., Azher, I., & Mahmood, Z. A. (2018). Photoprotective and antioxidant activities along with phytochemical investigation of rose water. International Journal of Pharmaceutical Sciences and Research, 9(12), 5320–5326.

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