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Formulation and Evaluation of a Biocompatible Natural Sunscreen Cream Containing Compritol 888 ATO and Essential Oils

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ABSTRACT

Background: Natural sunscreens are increasingly preferred due to their biocompatibility, antioxidant activity, and safety for sensitive skin. Plant-based oils and mineral ultraviolet filters offer multifunctional benefits and broad-spectrum protection, aligning with current demands for eco-friendly skincare.

Objective: To formulate and evaluate a stable, natural sunscreen cream using Compritol 888 ATO, carrot seed oil, rosemary essential oil, and zinc oxide for enhanced photoprotection and skin compatibility.

Methods: Three formulations (F1, F2, F3) were prepared with varying concentrations of natural actives. Evaluation included pH, spread ability, viscosity, stability, irritancy, and washability. *In-vitro* sun protection factor values were determined using Mansur's method, measuring ultraviolet absorbance from 290 to 320nm.

Results: All formulations had skin-compatible pH (6.2-6.6), smooth texture, and good spread ability (up to 14.9 g.cm/sec). No irritation or rancidity was observed. F3, the optimized formulation, showed the highest viscosity (16,950 cP), best stability, and an SPF of 13.82. The synergistic effects of carrot seed and rosemary essential oils, rich in natural antioxidants, along with zinc oxide's broad-spectrum blocking ability, contributes to improved ultraviolet protection. Compritol 888 ATO played a critical role in emulsion stability and enhanced application.

Conclusions: The developed natural sunscreen cream demonstrated excellent photoprotective efficacy, physicochemical stability, and biocompatibility. These findings support the use of natural oils and mineral filters in effective, skin-safe, and sustainable sun care products.

INTRODUCTION

Ultraviolet (UV) radiation from the sun is an integral part of solar energy and a main environmental factor influencing human health. Three wavelengths define UV radiation: UVA (320-400nm), UVB (280-320nm), and UVC (100-280nm). Although UVC is mostly absorbed by the earth's atmosphere, only UVA and UVB enters the skin and causes acute effects such as sunburn (erythema), DNA damage, oxidative stress, immune suppression and chronic effects such as photoaging, skin cancer, hyperpigmentation, actinic keratosis (pre-cancerous lesions), and UV-induced eye damage.[1] The sunscreen is one of the most widely used formulation that absorbs, reflects, or scatters UV radiation intended to prevent skin damage caused by UV rays.[2] The sunscreen is classified into physical (mineral), chemical, hybrid and natural types based on their UV protection mechanism and ingredients.

The increasing demand for organic, non-toxic and plant-based cosmetics is leading to a shift towards natural sunscreen formulation. The natural sunscreen has been gaining attention due to their biocompatibility, skin-nourishing properties, and safety for sensitive skin. The natural ingredients with SPF potential used in sunscreen include flavonoids, carotenoids, polyphenols and essential oils. They offer multifunctional activity including antioxidant, anti-inflammatory, and moisturizing effect. The essential oils significantly contribute to sunscreen development because of their UV protection, antioxidant activity and other benefits to the skin by neutralizing free radicals, minimizing oxidative stress, and defending against UV-induced damage in the skin. The most challenging factors in natural sunscreen development are skin penetration and even coverage. Natural filters like mineral sunscreens and essential oils tend to have poor skin penetration at some times, resulting in ununiform application and spotty protection. Formulation stability is another significant issue, with the right excipient is required to emulsify the stable natural sunscreen formulation effectively.[3] The aim of this study is the formulation and assessment of a natural sunscreen cream with the use of compritol 888 ATO as a multifunctional excipient and emulsifier, and carrot seed essential oil and rosemary essential oil, and blend of zinc oxide in order to achieve a stable and biocompatible sunscreen with UV protection, better consistency, and enhanced skin compatibility.

JUSTIFICATION FOR INGREDIENTS USED

Compritol 888 ATO: Glyceryl behenate is a lipid-based excipient that is frequently used in pharmaceutical and cosmetic product formulation under the trade name of Compritol 888 ATO. It assists in product smoothness and stability by functioning as a surfactant, emulsifier and viscosity modifier in creams and emulsions. It enhances sensory feel and protects formulation integrity in sun care, cosmetics, and skin care products by acting as an oil-phase thickening and consistency. It is versatile lipid excipient that improves topical sun care formulation stability, texture, and photoprotective function. It used as a thickener, emulsifier and viscosity modifier in the formation of stable emulsion and anhydrous balm, and its solid lipid formulation aids in reflecting and dispersing ultraviolet (UV) radiation, enhancing the sunscreen's overall UV protection. This not only improves the photoprotective and antioxidant performance of the sunscreen but also delivers a pleasant, non-greasy skin feel and prevents the whitening or soaping effect common to other waxes, resulting in a stable, effective, and consumer-friendly sun care product.[4-5]

Carrot seeds essential oil: The carrot seed essential oil is a highly concentrated oil, extracted through steam distillation from the dried seeds of wild carrot plant (Daucus carota). It is primarily rich in sesquiterpenes, with carotol being the dominant constituents that provides significant healing and regenerative properties of the skin. The oils are primarily rich in antioxidants, vitamins A and E, and some carotenoids such as beta-carotene. These substance hydrates, moisturizes, and feed the skin and reduces the wrinkles and fine lines.[6] Carrot seed oil provides significant UV protection is because it contains natural antioxidants like beta-carotene, carotenoids, and vitamin E, which neutralize free radicals generated by UV radiation and lessen oxidative stress on the skin with a natural SPF of 30 to 40. Studies revealed carrot seed oil to decrease the transmission of UVB light through sunscreen formulations and there by enhance the overall SPF and photoprotective effect. It also has anti-inflammatory properties that helps in soothing skin irritated by sun exposure and moisturize the skin.[7-8]

Rosemary essential oil: The rosemary essential oil is produced by steam distillation through natural extraction from rosemary leaves which belongs to the Rosmarinus officinalis species. It has extensive application in medicinal and cosmetic fields because it contains beneficial properties for skin and hair treatment. This essential oil contains rich bioactive compound such as carnosic acid, rosmarinic acid, urosolic acid, and other polyphenols and terpenes. These constituents act as strong antioxidants and anti-inflammatory agents that protects the skin from oxidative stress and reduce inflammation due to UV radiation exposure. Studies have shown that rosemary extracts can boost protection against cellular damage caused by UV radiation and lessen the damage to the skin caused by the skin, thus making it an important natural ingredient for sunscreen formulations. Besides this, rosemary oil aids the wound-healing process, maintains skin hydration, improves skin elasticity, and offers antimicrobial benefits that contribute to overall skin health and environmental stress barrier-building. It stabilizes emulsions, which further helps formulate topical products that improves the sunscreen performance.[9-10]

Zinc oxide: Zinc oxide is an inorganic compound used as a highly valued ingredients in skincare that act as a physical sunscreen that reflects and scatters harmful UVA and UVB rays due to its broad-spectrum sun protection. Thus, it prevents sunburn, premature aging, and skin care. It also acts as an antibacterial, anti-inflammatory, and astringent for acne-causing bacteria, it can dry out pores and regulate excessive oil production, reducing inflammation and soothing acne-pore skin. It works as a barrier that shields the skin from allergens and pollutants and its antioxidant properties help to protect collagen and elastin against free radicals and impart anti-aging properties by keeping skin firm. It is crucial component of sunscreen cream formulation. Zinc oxide gives immediate and long-lasting protection without being absorbed, in contrast to chemical sunscreen that absorbs UV radiation. It is suitable for variety of skin type due to its non-comedogenic properties, lower the skin irritation. Because it is biodegradable and regarded as reef-safe, its use in mineral sunscreens also provides an eco-friendly substitute for chemical sunscreens. All things considered, zinc oxide sunscreen provide a reliable, gentle, and broad-spectrum protection against sunburn, early aging, and skin cancer.[11-12]

Coconut oil: Coconut oil act as an antibacterial, anti-inflammatory, moisturizing, and wound-healing agent. By increasing the amounts of proteins like involucrin and filaggrin, coconut oil strengthens the epidermal barrier and provide antioxidant property against damage caused by reactive oxygen species. Studies have shown that coconut oil has moderate sun protection factor (SPF), depending on the formulation and concentration, contributing its role as a natural UV filters. These properties justify the use of coconut oil in the cream formulation, not only as a skin-conditioning agent but also act as mild UV radiation protecting agent, corresponding with the increasing need for skincare products that are safer and without skin irritation.[13–15]

Bees wax: When combined with oils, beeswax gives the sunscreen cream a solid texture and stabilizes the formulation. It is safe and advantageous for skin application because it is often non-irritating, has low comedogenic potential. It functions as an occlusive agent, creating a protective layer on the skin that decreases water loss and increases the sunscreen's water resistance, improving its durability on the skin and providing some natural defense against the sun's harmful rays.[16]

Glycerol: It is a natural humectant used widely in the sunscreen formulation which helps to attract and retain moisture in the outermost layer of the skin to maintain hydration and avoid dryness caused by sun exposure. It also improves the texture and spreadability of sunscreen cream, ensuring comfortable application.[17]

Xanthan gum: It act as a natural thickening and stabilizing agent in sunscreen cream formulation. It ensures even application, prevents ingredient separation, and maintain the sunscreen cream's texture and consistency.[18]

Methyl paraben: In cosmetic formulations, such as sunscreens, methyl paraben is a commonly used preservative to prevent microbial growth and prolong product shelf life.

MATERIALS AND METHODS

MATERIALS

Compritol 888 ATO (GATTEFOSSE SAS), Carrot seed essential oil (R.K's Aroma, Mumbai, India), Rosemary essential oil (Blossom Kochhar Beauty Products Pvt. Ltd, Haryana, India), Zinc oxide (Sisco Research Laboratories Pvt. Ltd.), Coconut oil (Local market), Bees wax (Sisco Research Laboratories Pvt. Ltd.), Glycerol (Sisco Research Laboratories Pvt. Ltd.), Xanthum gum, Methyl paraben (RFCL Limited), distilled water (College laboratory).

PREPARATION METHOD

The composition of the three prepared sunscreen cream formulations (F1, F2, and F3) is detailed in **Table 1**. These formulations were developed by varying the concentration of natural ingredients to evaluate their effect on the cream's physicochemical and photoprotective properties. The formulation primarily incorporates natural oils such as carrot seed essential oil, rosemary essential oil, selected for their moisturizing, antioxidant, and UV-protective properties. The visual representation of these oils used in the formulation process is depicted in **Figure 1**.

Step 1: Aqueous phase

- Glycerol and xanthan gum were accurately weighed and mixed together.

- The mixture was dispersed in a measured quantity of distilled water and heated on a thermostatically controlled hot plate at 45 ± 2 ºC
- Stirring until homogeneity ensures proper swelling of xanthan gum and uniform dispersion.
- The aqueous phase was kept warm until further use.

Step 2: Oil phase

- Coconut oil was weighed and transferred into a clean China dish.
- Beeswax wax was added and kept mixture on a hot plate at 45 ± 2 ºC with gentle stirring until beeswax melted completely.
- Compritol 888 ATO was then added and allowed to melt under continuous stirring.
- Once a homogenous mixture was obtained, zinc oxide was incorporated and stirred well to ensure uniform dispersion.
- The oil phase then removed from the heat source.

Step 3: Emulsification and final additions

- The preheated aqueous phase was slowly added to the oil phase under continuous stirring to initiate emulsification.
- Following emulsification, carrot seed essential oil and rosemary essential oil were added and thoroughly mixed to ensure uniform distribution of the essential oils throughout the formulation.
- This mixture was stirred until a uniform cream-like consistency was achieved.
- Finally, Methyl paraben was added as a preservative, and the cream was stirred until complete homogeneity was achieved.

EVALUATION PARAMETER

PHYSICAL PARAMETER

Appearance: Visual inspection for uniformity, texture, consistency, homogeneity and color (white)

Odor: By applying the cream on the skin surface, the smell was checked.[19]

SPREAD ABILITY TEST

The spread ability test for topical formulations, including sunscreen, is commonly performed using the glass slide method. In this procedure, a 100mg of cream is placed on a clean glass slide, and another slide is placed over it, so that the cream is sandwiched between the slides. 100g of weight is applied on the upper slide for 5 minutes to allow the sample to spread evenly. After removing the weight, the excess cream is wiped off, and the upper slide is attached to a string with a 60g of weight hanging from it. The time required for the upper slide to move 5cm distance under the influence of weight is recorded.[19]

$$S = (M \times L) / T$$

S is Spread ability,

M is the weight tied to the upper slide,

L is the length of the glass slide,

T is the time taken to move the distance.

DETERMINATION OF PH

The pH of sunscreen was determined using a digital pH meter. A digital pH meter was previously calibrated with standard buffer solutions Then weighed quantity of 1g of sunscreen cream was dissolved in 100 ml of suitable solvent. The mixture is stirred thoroughly, using a magnetic stirrer, for about 5-10 minutes to form a uniform suspension. Then pH meter electrode is immersed into the suspension, and the pH reading is recorded for sunscreen cream. This process is repeated at least three times with separate samples to ensure accuracy and reproducibility, and the mean pH value is reported.[19]

DETERMINATION OF VISCOSITY

The viscosity of a cream is determined using a Brookfield viscometer, with the proper number of spindles selected. A 50g of cream is transferred into the sample container of the viscometer. The appropriate spindle is selected and immersed in the cream. Then, the viscosity was directly measured at 10 revolutions per minute (rpm) and recorded the value displayed in centipoise (cP).[19]

$$\text{Viscosity(cP)} = \text{Dial reading} \times \text{Factor}$$

WASHABILITY

This evaluates how easily the product can be removed from the skin with water to ensure consumer ease and product acceptance. A small amount of cream is evenly applied on a defined area of skin and allowed to remain for a short period. Then this test is carried out by simply washing applied sunscreen cream with water.[20]

IRRITANCY TEST

In this test, a small amount of the cream is applied to a defined area of the skin and the area is marked (one sq. cm). The skin is observed at intervals (24, 48, 72 hours) for any signs of redness, swelling, itching, edema and edema.[20]

RANCIDITY TEST

This test is used to determine the oxidative stability and shelf life of oils and fats present in natural sunscreen. It determines whether the oils have oxidized or hydrolyzed, leading to spoilage characterized by unpleasant odors, off-flavors, and deterioration in quality. The 10ml of cream was taken and melted, then added to the mixture of 10ml of hydrochloric acid and 10ml of phloroglucinol solution. The mixture was shaken well for one minute. The test passed if no pink color develops.[20]

LOSS ON DRYING

This test is used to determine the moisture and volatile content by measuring weight loss after drying a sample under controlled conditions. 1g of formulated cream is accurately weighed and allowed to dry in hot air oven at 100 °C for 30 minutes. After drying, cool the sample in a desiccator and reweigh it and LOD is determined.[21]

LOD % = Initial weight – Final weight / Initial weight ×100

STABILITY TESTING

Stability testing of the prepared formulation was conducted initially at room temperature and studied for 7 days. Subsequently, the formulation was stored at an elevated temperature of 45 ± 1 ºC for 20 days. Samples were kept at both room temperature and elevated temperature conditions and observed on the 5th, 10th, 15th, and 20th days for all the evaluation parameters.[20]

IN-VITRO SPF DETERMINATION

For *in-vitro* SPF determination, 1g of the formulated sunscreen cream was accurately weighed and transferred to a clean beaker, followed by the addition of 20ml of a solvent mixture consisting of isopropyl myristate and ethanol in a 9:1 ratio. The mixture was stirred for 30 minutes using a magnetic stirrer to facilitate the extraction of UV-absorbing components. Then the mixture was filtered through Whatman No.1 filter paper to remove any undissolved residues. The resulting filtrate was transferred to a 100ml volumetric flask and the volume was made up with the same IPM:ethanol solvent. If necessary, a 1:10 dilution was performed to bring the absorbance within the spectrophotometer's linear range (2.0 to 1.0). The UV absorbance of the final solution was measured using a UV-Visible spectrophotometer in the range of 290 to 320nm at 5nm intervals, using the IPM:ethanol mixture as the blank. Absorbance values were recorded at 290, 295, 300, 305, 310, 315, and 320nm for subsequent SPF calculation.[20]

SPF Calculation

Mansur's Equation

$$\mathbf{SPF = CF \times \sum(EE(\lambda) \times I(\lambda) \times Abs(\lambda)),\ from\ \lambda = 290\ to\ 320\ nm}$$

Where:

CF = 10 (Correction Factor based on standard protocol)

EE(λ) = Erythemal effect

I(λ) = Solar intensity

Abs(λ) = Absorbance of sunscreen

As shown in **Table 2, EE(λ) × I(λ)** is constant value

RESULTS

Table 3. Determination of evaluation parameter of prepared natural sunscreen cream

Determination of SPF (Sun Protection Factor):

Table 4. SPF for formulation F1, F2, F3

SPF (Sun Protection Factor) = C.F × 0.889

= 8.89

SPF (Sun Protection Factor) = C.F × 1.253

= 12.53

SPF (Sun Protection Factor) = C.F × 1.382

= 13.82

As shown in the **Table 3**, F3 demonstrated optimal performance with superior physicochemical properties, and stability. It exhibited the highest spreadability (14.9 g.cm/sec), viscosity (16,950 cP), and a skin-compatible pH of 6.6. *In-vitro* SPF determination revealed that F3 had the maximum SPF value of 13.82, indicating enhanced UV protection. The improved SPF was attributed to the increased concentration of carrot seed oil, rosemary essential oil, and zinc oxide, which contributed synergistically to photoprotection. Stability testing confirmed that F3 remained stable at room temperature and under accelerated conditions (45 ± 1ºC) for 20 days without any signs of phase separation, rancidity, or changes in texture. These results suggest that F3 is a promising formulation for natural and biocompatible sunscreen development.

DISCUSSION

The present study successfully formulated a natural sunscreen cream incorporating Compritol 888 ATO, carrot seed essential oil, rosemary essential oil, zinc oxide, and other natural excipients, aiming to achieve a stable, biocompatible, and effective photoprotective product. The results demonstrated that the combination of these ingredients not only provide UV protection but also enhanced the formulation stability, skin compatibility, and sensory attributes.

Three formulations (F1, F2, F3) were developed and evaluated for various physicochemical parameters, stability, and in-vitro SPF. Among these F3 was identified as the optimized formulation based on overall performance. The visual appearance and texture are crucial for consumer acceptance. As shown in **Figure 2**, F1 showed grainy and thick consistency likely due to improper emulsification possibly influenced by the lower concentration of Compritol 888 ATO and essential oils. As shown in **Figure 3 and 4**, F2 and F3 exhibited smooth, homogenous textures, reflecting successful emulsification and better formulation stability. The spread ability test demonstrated that increasing the concentration of oils and emulsifiers improved the stability, with F3 showing the highest value (14.9 g.cm/sec). This property is essential for even application and effective skin coverage. Similarly, the pH values of all formulations remained within skin-compatible range, minimum potential for irritation and supporting the suitability for topical use.

The increase in viscosity from F1 to F3 is attributed to higher concentrations of Compritol 88 ATO, beeswax, and coconut oil. Coconut oil, due to its semi-solid nature and emollient properties, enhances viscosity while improving texture and skin adherence. Washability, irritancy, and rancidity tests confirmed that all formulations were safe, washable, and stable against oxidation. Notably, the absence of pink coloration in the rancidity test indicates no oxidative degradation, which is crucial for the shelf life of natural creams. The loss on drying (LOD) values decreased from F1 (3.45%) to F3 (2.35%), further validating the formulation's stability by minimizing water loss and volatility. Stability testing over 20 days at room and accelerated temperatures revealed that F3 and F2 retained its physical and chemical properties, while F1 showed signs of instability, likely due to insufficient emulsifier content.

The in-vitro SPF determination using Mansur's method demonstrated a gradual increase in SPF values from F1(8.89), F2(12.53) and F3(13.82) as shown in **Table 4**. This progression aligns with the increasing concentrations of Carrot seed oil, rosemary oil, and zinc oxide. Carrot seed oil, reported to possess natural SPF, rosemary essential oil, known for their antioxidant properties, enhanced the UV absorption capacity. Additionally, zinc oxide's role as a broad-spectrum UV filter.

The UV absorbance profile **Figure 5** clearly demonstrates that the absorbance values increase progressively from F1 to F3, aligning with the respective SPF values **Table 4.** F1 exhibited low and nearly flat absorbance across all wavelengths, indicating poor UVB protection. F2 showed a sharp absorbance at lower wavelengths (290-300nm) but declined thereafter, reflecting moderate protection. In contrast, F3 maintained consistently high absorbance across the full UVB range, indicating strong and uniform photoprotection. It correlates with the Mansur's method SPF results where F3 recorded the highest SPF (13.82).

Overall, this study validates the approach of combining natural oils with mineral UV filters and multifunctional excipients to develop a natural sunscreen cream that offers effective photoprotection, antioxidant property, and consumer-friendly properties.

CONCLUSION

The present study successfully demonstrated the formulation of skin-safe and biocompatible natural sunscreen cream by incorporating Compritol 888 ATO, carrot seed oil, rosemary essential oil, and zinc oxide. The formulation F3 showed excellent physicochemical stability, desirable sensory attributes, and UV protection with an in-vitro SPF of 13.82. The cream exhibited no signs of skin irritation, rancidity, or instability, confirming its suitability for prolonged topical application on sensitive skin types. The use of naturally derived ingredients, known for their antioxidant, anti-inflammatory, and UV-blocking properties, contributes not only to photoprotection but also to maintaining the skin's barrier integrity and promoting skin compatibility. This work supports the growing demand for natural, skin-safe, and environmentally friendly sun care products.

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CONFLICT OF INTEREST

The authors declare no conflict of interest in relation to this study or its publication.

ABBREVIATIONS

SPF - Sun Protection Factor

UV – Ultraviolet

UVA – Ultraviolet A (320-400nm)

UVB – Ultraviolet B (280-320nm)

UVC – Ultraviolet C (100-280nm)

Cp – Centipoise

LOD - Loss on Drying

EE × I – Erythemal Effect × Solar Intensity

SUMMARY

This study focuses on the formulation and evaluation of a natural sunscreen cream utilizing Compritol 888 ATO, carrot seed essential oil, rosemary essential oil, and zinc oxide to provide enhanced UV protection. Three formulations (F1, F2, F3) were developed and evaluated for their physicochemical properties and *in-vitro* sun protection factor (SPF) using Mansur's method. Among the tested for formulations, F3 showed the most promising results with a high SPF of 13.82, superior spreadability, stability, and biocompatibility. The combination of antioxidant-rich essential oils with mineral UV filters and a lipid-based emulsifier resulted in a stable, effective, and skin-safe sunscreen formulation. These findings advocate for the use of natural and eco-friendly ingredients in topical sun care products, aligning with the growing demand for safe and sustainable cosmetics.

REFERENCE

1. Tang X, Yang T, Yu D, Xiong H, Zhang S. Current insights and future perspectives of ultraviolet radiation (UV) exposure: Friends and foes to the skin and beyond the skin. Environ Int. 2024 Mar 1;185:108535.

2. Kaimal S, Abraham A. Sunscreens. Indian J Dermatol Venereol Leprol. 2011 Mar 1;77:238.

3. He H, Li A, Li S, Tang J, Li L, Xiong L. Natural components in sunscreens: Topical formulations with sun protection factor (SPF). Biomed Pharmacother Biomedecine Pharmacother. 2021 Feb;134:111161.

4. Aburahma MH, and Badr-Eldin SM. Compritol 888 ATO: a multifunctional lipid excipient in drug delivery systems and nanopharmaceuticals. Expert Opin Drug Deliv. 2014 Dec 1;11(12):1865–83.

5. Compritol® 888 ATO from Gattefossé - Product Description and Details [Internet]. [cited 2025 Jun 12]. Available from: https://www.americanpharmaceuticalreview.com/25260-Excipient-Search/12820162-Compritol-888-ATO/

6. Sieniawska E, Świątek Ł, Rajtar B, Kozioł E, Polz-Dacewicz M, Skalicka-Woźniak K. Carrot seed essential oil—Source of carotol and cytotoxicity study. Ind Crops Prod. 2016 Dec 15;92:109–15.

7. Chinnappan S, Yuan WS, Ming LY, Jie TZ, Le TJ, Panneerselvam J, *et al*. Natural Essential Oils for Antiaging: A Review. Res J Pharm Technol. 2024 May 15;17(5):2398–404.

8. Sharma AK, Maury S. A REVIEW ON, "SUNSCREEN: USING NATURAL AGENTS."

9. de Macedo LM, Santos ÉM dos, Militão L, Tundisi LL, Ataide JA, Souto EB, *et al*. Rosemary (Rosmarinus officinalis L., syn Salvia rosmarinus Spenn.) and Its Topical Applications: A Review. Plants. 2020 May;9(5):651.

10. González-Minero FJ, Bravo-Díaz L, Ayala-Gómez A. Rosmarinus officinalis L. (Rosemary): An Ancient Plant with Uses in Personal Healthcare and Cosmetics. Cosmetics. 2020 Dec;7(4):77.

11. Kołodziejczak-Radzimska A, Jesionowski T. Zinc Oxide—From Synthesis to Application: A Review. Materials. 2014 Apr;7(4):2833–81.

12. PubChem. Zinc Oxide [Internet]. [cited 2025 Jun 13]. Available from: https://pubchem.ncbi.nlm.nih.gov/compound/3007857

13. Varma SR, Sivaprakasam TO, Arumugam I, Dilip N, Raghuraman M, Pavan KB, *et al*. *In vitro* anti-inflammatory and skin protective properties of Virgin coconut oil. J Tradit Complement Med. 2019 Jan 1;9(1):5–14.

14. Chew YL. The Beneficial Properties of Virgin Coconut Oil in Management of Atopic Dermatitis. Pharmacogn Rev. 2019;13(25):24–7.

15. Kaur C, Saraf S, Saraf S, Saraf S. In vitro Sun Protection Factor Determination of Herbal Oils used in Cosmetics. Pharmacogn Res. 2010;2(1):22–5.

16. Nong Y, Maloh J, Natarelli N, Gunt HB, Tristani E, Sivamani RK. A review of the use of beeswax in skincare. J Cosmet Dermatol. 2023;22(8):2166–73.

17. Roussel L, Atrux-Tallau N, Pirot F. Glycerol as a Skin Barrier Influencing Humectant [Internet]. Lodén M, Maibach HI, editors. Treatment of Dry Skin Syndrome: The Art and Science of Moisturizers. Berlin, Heidelberg: Springer Berlin Heidelberg; 2012. p. 473–80. Available from: https://doi.org/10.1007/978-3-642-27606-4_32

18. Chaturvedi S, Kulshrestha S, Bhardwaj K, Jangir R. A Review on Properties and Applications of Xanthan Gum. In: Vaishnav A, Choudhary DK, editors. Microbial Polymers: Applications and Ecological Perspectives [Internet]. Singapore: Springer Singapore; 2021. p. 87–107. Available from: https://doi.org/10.1007/978-981-16-0045-6_4

19. Agrawal DrHS. Review of Formulation and Evaluation of Sunscreen. Int J Res Appl Sci Eng Technol. 2025 Jan 31;13(1):1833–8.

20. Anusha V, Moulika P, Jadhav SC, Seshasarvani N, Kumar YG, Sushma K. Formulation and Evaluation of Herbal Sunscreen Cream Encompassed With Tomato, Papaya, Aloe Vera, Sandalwood Natural Extracts for Essential Sun Protection Factor and UV Protection. Asian J Pharm Res Dev. 2025 Apr 15;13(2):01–11.

21. Manisha Mishra* AG. Formulation and Evaluation of Sunscreen Cream Using Natural Herbs. 2024 Aug 3 [cited 2025 Jun 22]; Available from: https://zenodo.org/doi/10.5281/zenodo.13195153

FIGURES:

A **B** **C**

Figure 1. Oils used in the preparation of natural sunscreen cream

Figure 2. Prepared sunscreen cream Formulation 1

Figure 3. Prepared sunscreen cream Formulation 2

Figure 4. Prepared sunscreen cream Formulation 3

TABLES:

S.no	Ingredients	Uses	F1	F2	F3
1.	Coconut oil	Moisturizer, mild UV protection	15ml	20ml	25ml
2.	Bees wax	Thickener, emollient	2g	2g	2g
3.	Compritol 888 ATO	Thickener, emulsifier, stabilizer.	1g	2g	3g
4.	Zinc oxide	Physical UV blockers	8g	9g	10g
5.	Glycerol	Moisturizer, humectant	3ml	3ml	3ml
6.	Xanthan gum	Natural thickener, stabilizer	0.3g	0.3g	0.3g
7.	Carrot seeds essential oil	UV protection, antioxidant	1ml	1.5ml	2ml
8.	Rosemary essential oil	Anti-oxidant	1ml	2ml	3ml
9.	Distilled water	Vehicle, hydrates skin	q.s	q.s	q.s
10.	Methyl paraben	Preservative, antimicrobial	0.3g	0.3g	0.3g

Table 1. Formulation of natural sunscreen cream

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

Table 2. Constant values of EE × I between 290 to 320nm

Parameters	Formulation 1	Formulation 2	Formulation 3
Appearance	Grainy	Good	Good
Color	White	White	White
Consistency	Thick	Homogenous	Homogenous
Texture	Grainy	Smooth and spreadable	Smooth and spreadable
Odor	Characteristic	Characteristic	Characteristic
Spread ability (g.cm/sec)	10.7	14.2	14.9
pH	6.2	6.5	6.6
Viscosity	13250	16800	16950
Washability	Washable	Washable	Washable
Irritation test	No irritation	No irritation	No irritation
Rancidity	No pink color	No pink color	No pink color
Loss on Drying (%)	3.45	2.84	2.35
Stability testing	Unstable	Stable	Stable

Table 3. Determination of evaluation parameter of prepared natural sunscreen cream

Wavelength	EE × I	Absorbance	EE × I × Abs (F1)	Absorbance	EE × I × Abs (F2)	Absorbance	EE × I × Abs (F3)
290	0.0150	0.2515	0.0037225	2.211	0.033165	1.412	0.02118
295	0.0817	0.2491	0.02035147	1.762	0.1439554	1.401	0.1144617
300	0.2874	0.2484	0.7139016	1.573	0.4520802	1.385	0.398049
305	0.3278	0.2466	0.08083548	1.149	0.3766422	1.382	0.453019
310	0.1864	0.2466	0.04596624	0.935	0.174284	1.379	0.257045
315	0.0839	0.2454	0.02058906	0.792	0.0664488	1.362	0.114271
320	0.018	0.2453	0.0044154	0.479	0.008622	1.351	0.024318
			Total: 0.889		Total: 1.253		Total: 1.382

Table 4. SPF for formulation F1, F2, F3

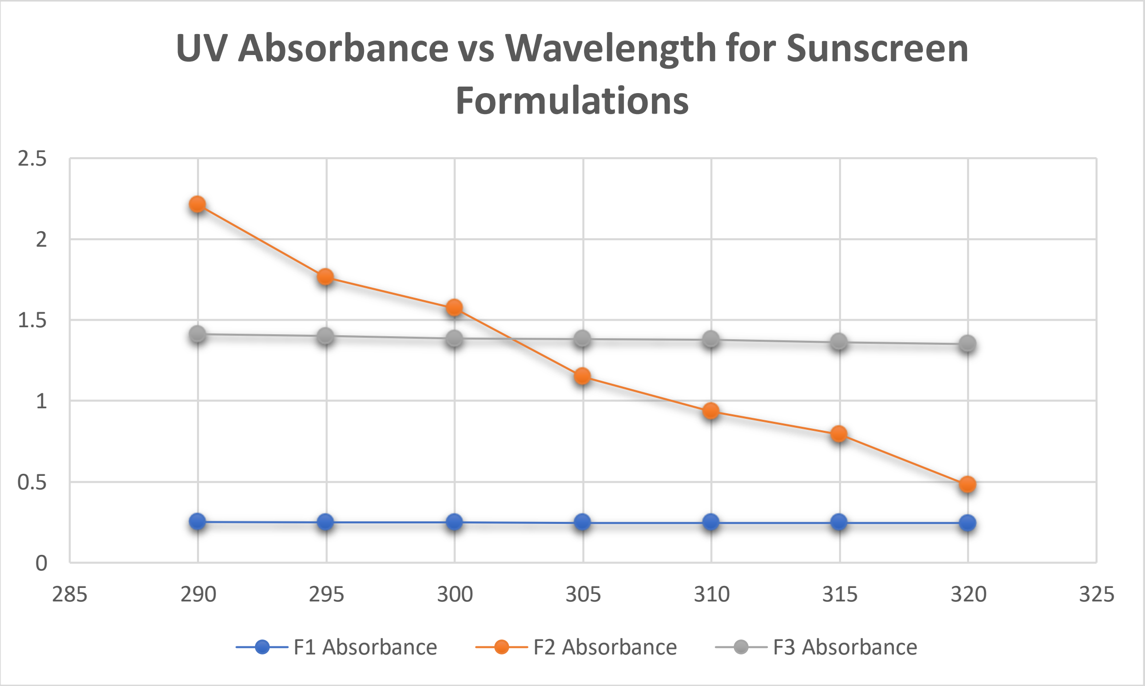

Figure 5. UV absorbance vs wavelength for sunscreen cream formulation