

Development and Evaluation of Herbal Sunscreen Using *Rhododendron barbatum* Flower Extract

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ABSTRACT

The damaging effects of ultraviolet (UV) radiation on the skin include skin burns, photoaging, hyperpigmentation, and skin cancer. Sunscreens are extensively utilized for UV protection. Herbal sunscreens have recently been considered because of their safety, antioxidant potential, and fewer side effects. The flowers of *Rhododendron barbatum* contain flavonoids, phenolics, tannins, and saponins that impart photoprotective properties to the flowers. Hydroalcoholic extraction was carried out using a maceration process, where ethanol and water were used in 70:30 ratio. The phytochemical analysis was undertaken on *R. barbatum* flowers. Three different formulations were used (F1, F2, and F3). These were screened against various parameters, including colour, pH, spreadability, washability, stability, and patch tests, and SPF determination using the Mansur equation. Phytochemical screening revealed the presence of flavonoids, phenolics, tannins, and saponins. All formulations exhibited good physicochemical properties. Among the formulations, F3 was most homogeneous, spreadable, and stable. The patch test revealed that the formulation was non irritating. In the SPF evaluation, F3 provided an SPF value of approximately 8. The SPF activity is due to the presence of flavonoids and phenols that exhibit good antioxidant properties and UV absorptive properties. This helps prevent oxidative stress and UV-induced damage. The enhanced activity exhibited by formulation F3 can be attributed to the higher concentration of extracts present in this formulation. The herbal sunscreen cream was chemically and physically stable, safe, and showed moderate photoprotective efficacy. Therefore, it can be considered an alternative to artificial sunscreen creams.

Keywords: Herbal sunscreen, *Rhododendron barbatum*, ultraviolet radiation, SPF, flavonoids, photoprotection.

INTRODUCTION

The skin is the biggest organ in the body. The skin is comprised of two major layers called the epidermis and the dermis. The epidermis, which is derived from the ectoderm, is the outer layer of the skin and acts as the body's interface with the external environment. Biological and physical features of the epidermis significantly contribute towards the skin's resistance to various environmental stresses, such as infectious organisms, chemicals, and ultraviolet rays. Keratinocytes are the most prevalent cells found in the epidermis, while the dermis comprises numerous

immune cells and fibroblasts that are actively involved in several physiological reactions within the skin. The dermis forms the key protective barrier in the epidermis. Melanin content in the epidermis accounts for the most important factor for determining skin complexion and ultraviolet rays' susceptibility. Melanin is a large biopolymer molecule consisting of smaller units of several pigment types, synthesized from oxidation and cyclization of tyrosine. [1]

Two types of melanin include eumelanin which is a type of dark pigment found in plenty in the skin of highly pigmented people, and pheomelanin, which is

a lighter sulphated pigment produced by incorporation of cysteine into melanin precursors. [2] Eumelanin is highly effective in shielding against the photons of UV light compared to pheomelanin; hence, the higher the quantity of eumelanin present in the skin, the less permeable to UV the epidermis becomes [2]. The UV-sensitive people with fair skin and a greater risk of developing skin cancer due to the lack of sufficient epidermal eumelanin “feel” the UV rays far more intensely than their counterparts with a darker skin. As such, the paler an individual’s skin is, the more harmful the exposure to UV radiation will be for him/her. Notably, pheomelanin concentrations are the same for both light and dark individuals, while eumelanin content in the skin determines skin pigmentation, sensitivity to UV rays and cancer incidence. According to data, pheomelanin contributes to oxidative damage to DNA and development of melanoma by producing free radicals in the melanocytes without exposing them to UV. UV exposure contributes to 65% of melanoma instances and 90% of KC. [3]

Sunscreens were initially formulated with the primary purpose of preventing erythema. The end result of the primary index of the efficacy of a sunscreen is erythema, although SPF primarily indicates protection against UVB radiation. However, several studies on animals as well as humans have proven that there are several harmful effects which may follow sub erythema exposure to sunlight with UVR. Therefore, it became apparent that any sunscreen to effectively protect against harm other than sunburn must offer protection against the entire spectrum of the solar UVR spectrum. [4]

It is widely accepted that ROS are the major cause of damage in the form of skin cancer, actinic keratosis, and photoaging caused by continuous exposure to sunlight. Therefore, the use of antioxidants, together with UV filters, in sunscreens can help increase the effectiveness of these products in preventing skin

cancer and photoaging. The complexity of plant extracts and oils leads to different biological activities, including antioxidant activity, sun-blocking activity, anti-inflammatory, and immunomodulating activities. Moreover, the effectiveness of plant extracts in improving skin condition and curing different skin disorders has been thoroughly investigated. Plants possessing high antioxidant activity are considered to be highly attractive ingredients for inclusion into sunscreens for protection from sunlight-induced skin damages. [5]

Rhododendron barbatum of Ericaceae family is an evergreen tree, widely distributed in the temperate regions of tropics. [6]

This study has been carried out in the temperate, subalpine and alpine regions of the Pindari Glacier (33° 85’ 0” to 30° 81’ 0” N to 79° 48’ 0” to 79° 52’ 0” E) in the Kumaon Himalayan region of the Central Himalaya of India. It is gradually replaced by *R. barbatum* in the birch. [7]

Ericaceae Family is a family of plants that have been found to grow in harsh and nutrient-deficient environments and can thrive under extreme climatic conditions at mountain peaks, arctic conditions, volcanos, swamps, rocks and are extensively distributed in temperate and cool subtropical regions. They are also referred to as Buransh in India. Local name – Lal Chimal. [7]

The phytochemicals found in *R. barbatum* flowers include flavonoid, glycoside, phenolic, quercetin, oleanolic acid, β -sitosterol, which possess medicinal, antioxidant, anti-inflammatory, and photoprotective properties. This is because *R. barbatum* flowers possess numerous bioactive phytochemicals such as. [6]

1.1 Taxonomical classification

Taxonomic Rank	Classification
Kingdom	Plantae
Division	Magnoliophyte
Class	Equisetopsida
Order	Ericales
Family	Ericaceae
Genus	Rhododendron
Species	<i>Rhododendron barbatum</i>

2. MATERIAL AND METHOD

2.1 Plant material

Herbal sunscreen creams were prepared by using plant material such as *Rhododendron barbatum* (Family: Ericaceae). Fresh flower of *Rhododendron barbatum* were collected from Munsyari region of Uttarakhand, India. Plant identification was carried out based on morphological characteristics and available botanical literature.

2.1 Chemicals

Stearic acid, Liquid paraffin, Methyl Paraben, Triethanolamine, Glycerin, Ethanol, Disodium EDTA, all chemicals and reagents used in the present study were of analytical grade and obtained from the laboratory of Amrapali university. [8]

2.3 Extraction of plant material

2.3.1 Maceration of *Rhododendron barbatum* Flowers

Fresh and healthy plant material of *Rhododendron barbatum* was procured and cleaned using water. It was shade-dried and converted to a fine powder using sieve number 80. A definite quantity of flower powder was taken (10g) after weighing and added with 70% ethanol followed by adding distilled water at 30%. This process was performed for 3 days continuously, with daily stirring after every 24 hours. Further, filtration and concentration were performed to get a semi-solid extract called Hydroalcoholic Extract. The extract was preserved in an airtight box. (Fig2)[9]



Fig2: Hydroalcoholic Extraction process of *Rhododendron barbatum* Flower

Table 2: Parameters used for extraction of *Rhododendron barbatum* Flowers

Parameters	Details
Plant used	<i>Rhododendron barbatum</i> Flowers
Extraction Method	Maceration
Solvent used	Hydroalcoholic solvent
Ethanol: water ratio	70:30(v/v)
Powder quantity	10g
Extraction Time	3days
Stirring interval	Every 24hr
Filtration method	Whatman filter paper
Final extract	Semisolid hydroalcoholic extract

2.4 Preliminary phytochemical test

Table 3: Preliminary phytochemical screening of *Rhododendron barbatum* extract[10]

S. No.	Phytochemical test	Test	Procedure	Observation
1	Flavonoids	Shinoda test	2ml, extract + small piece of magnesium ribbon + 1ml concentrated HCL	Red color observed
2	Phenols	Ferric Chloride test	2ml, extract + 1ml ferric chloride solution	Black color observed
3	Tannins	Ferric Chloride test	2ml, extract + 1ml ferric chloride solution	Black color observed
4	Saponin	Foam test	2ml, extract + 5ml distilled water, shake well	persistent foam formation

3. Formulation of Herbal sunscreen

3.1 Preparation of Oil Phase

Stearic acid 4 g and liquid paraffin 2 ml were accurately weighed and transferred into a clean dry beaker. The ingredients were heated on a water bath at approximately 70°C until completely melted and add glycerin 2 ml into the molten mixture with continuous stirring to obtain a uniform oil phase.

3.2 Preparation of Aqueous Phase

Distilled water q.s. to 20 gm was taken in a separate beaker and heated to approximately 70°C. Methyl paraben 0.04 g and disodium EDTA (0.02 g) were dissolved completely in the heated aqueous phase and add triethanolamine 0.4 g slowly with continuous stirring to prepare a clear and uniform aqueous phase.

3.3 Emulsification and Incorporation of Hydroalcoholic Extract

The hot aqueous phase was added gradually into the oil phase with continuous stirring to form a smooth emulsion. The prepared hydroalcoholic extract of *Rhododendron barbatum* (3 ml) was incorporated slowly into the formulation with constant stirring to ensure uniform distribution. Continuous stirring was maintained until a homogeneous sunscreen cream was obtained, final formulation was allowed to cool to room temperature and transferred into a clean airtight container for further evaluation and storage. (Fig3)[11], [12]



Formulation 1

Formulation 2

Formulation 3

Fig 3: Prepared formulations of F1, F2 and F3 herbal sunscreen

Table 4: Formulation and ingredient of Sunscreen

S. NO.	Ingredient	F1	F2	F3
1	<i>Rhododendron barbatum</i> (Buransh) extract	1ml	2ml	3ml
2	Stearic acid	3g	3.5g	4g
3	Liquid paraffin	1.5ml	2ml	2ml
4	Methyl paraben	0.04g	0.04g	0.04g
5	Glycerin	2ml	2ml	2ml
6	Disodium EDTA	0.02g	0.02g	0.02g
7	Triethanolamine	0.4g	0.4g	0.4g
8	Purified water	11ml	9.5ml	8.54ml
	Total	20g	20gm	20gm

4. Evaluation of herbal sunscreen

• Physical Appearance

To observe the color, texture, consistency, and presence of any grittiness or lumps in the sunscreen cream. • Visually inspect the prepared cream under proper lighting conditions. Observe White colored, smooth, uniform, soft, and non-gritty cream with pleasant appearance. [13]

• Homogeneity

To check the uniform distribution of ingredients in the formulation. A small quantity of cream was pressed between thumb and index finger to observe uniformity

and presence of aggregates. Observed The formulation showed good homogeneity with no phase separation or coarse particles. [13]

pH Determination

To ensure the cream is skin-friendly and suitable for topical application. Weigh 1 g of cream and disperse it in 50 mL distilled water. Measure the pH using a calibrated digital pH meter, observed pH found to be 5.5–6 which is suitable for skin application. [14]

Spreadability

To determine how easily the cream spreads on the skin surface.: Place 1 g of cream between two glass slides.

Apply 500 g weight for 5 minutes and measure the spread diameter, Observed Cream showed good spreadability 5.5 cm spread diameter, indicating ease of application. [15]

- **Washability**

To determine the ease of removal of cream from the skin using water. Apply a small amount of cream on skin and wash with tap water. Observe the ease of removal. observed, the cream was easily washable with water and did not leave excessive oily residue. [16]

- **Stability Study**

To evaluate the stability of the formulation under different storage conditions. Store the cream at room temperature and accelerated conditions ($40^{\circ}\text{C} \pm 2^{\circ}\text{C}$) for 30 days. Observe changes in color, odor,

consistency, and phase separation. observed No significant changes in appearance, color, pH, or consistency were observed during the study period, indicating good stability. [13]

- **Patch Test**

To evaluate the skin irritation potential and safety of the herbal sunscreen cream for topical application. A small quantity of the cream was applied on the inner forearm of volunteers and kept for 24 hours. The applied area was observed for redness, itching, irritation, or swelling. observed No redness, itching, irritation, or swelling was observed. The formulation was found to be safe and non-irritant for skin application. [17]

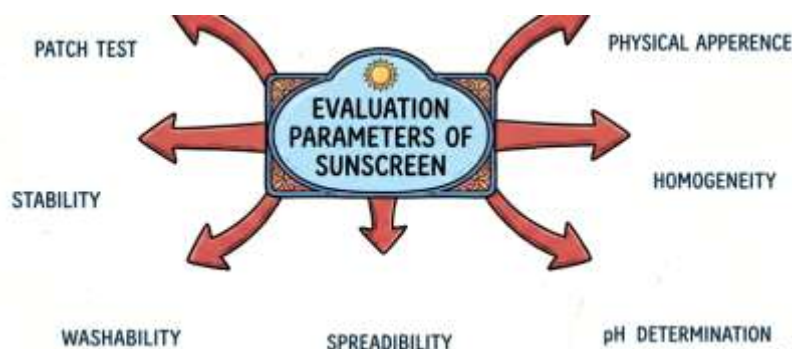


Fig 4: Evaluation parameters for Sunscreen

5. SPF (Sun Protection Factor) Determination

To evaluate the sun protection efficiency of the sunscreen cream. SPF value was determined using UV spectrophotometric method by measuring absorbance

between 290–320 nm The formulation exhibited satisfactory SPF value, indicating effective sunscreen activity. [18]

Table 5: Comparative study of prepared formulations

S.NO	Test Name	Purpose	Method	F1	F2	F3
1	Physical appearance	To check the color, texture, and uniformity of cream	Visual observation under proper lightening	White, smooth cream	White, smooth cream	White, smooth cream
2	Homogeneity	To ensure uniform mixing of ingredients	Press small quantity between finger	Moderate homogeneity, tiny lumps	Very good homogeneity	Excellent homogeneity
3	Ph Determination	To assess skin Compatibility	1g cream dispersed in distilled water and measured using pH meter	5.56	5.51	5.58
4	spreadability	To assess skin application	Cream placed between glass slides and spread diameter measured	Moderate spreadability	Good spreadability	Excellent spreadability
5	Washability	To check removability from skin	Applied on skin and washed with water	Easily washable	Easily washable	Easily washable
6	Stability study	To evaluate formulation stability	Stored at room temperature and observed for change	Moderate Stable	Highly Stable, no phase separation	Highly Stable, no phase separation

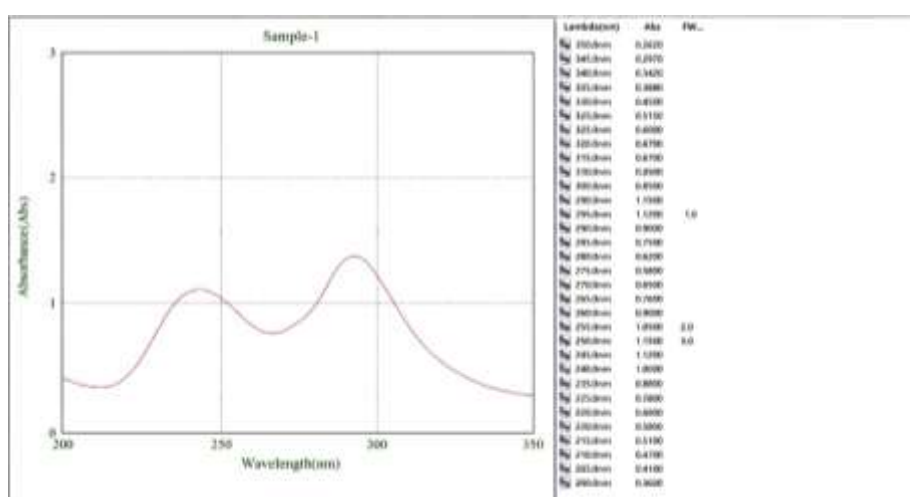


Fig 7: UV absorption graph of F3 formulation

SPF Calculation by Mansur Method

Using the absorbance values from your generated UV spectrum:

Wavelength (nm)	Absorbance
290	0.9000
295	1.1200
300	0.8500
305	0.8500
310	0.7500
315	0.6700
320	0.6700

Mansur Equation

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

Where:

$$CF = 10$$

Standard EE × I Values

Wavelength (nm) EE × I

Standard EE × I Values

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

Table 6: Detailed Calculation

Wavelength	Abs	EE × I	EE × I × Abs
290	0.9000	0.0150	0.01350
295	1.1200	0.0817	0.09150
300	0.8500	0.2874	0.24429
305	0.8500	0.3278	0.27863
310	0.7500	0.1864	0.13980
315	0.6700	0.0839	0.05621
320	0.6700	0.0180	0.01260

Sum of all values

$$\sum (EE \times I \times Abs) = 0.8360$$

Final SPF

$$SPF = 10 \times 0.8360$$

$$SPF = 8.36$$

6. RESULT AND DISCUSSION

The herbal sunscreens preparations, namely, F1, F2, and F3, produced by *Rhododendron barbatum* flower extracts possessed excellent physicochemical characteristics. Phytochemical analysis revealed that these sunscreens contain flavonoids, phenolic, tannin, and saponin compounds having antioxidant and sun protection abilities. All three formulations were found to be homogeneous in texture, pleasant in appearance, had an appropriate pH level, good skin cleansing property, and free from any skin irritancy.

Out of the three sunscreens, F3 proved superior in homogeneity, spreadability, and stability. SPF determination by UV spectrophotometric method demonstrated that SPF was found maximum for F3 at a value of 8.36. This implies that the sunscreen was able to exhibit its desired activity. The increased SPF might be attributed to the presence of a high content of flavonoid and phenolic compounds in the extracts.

7. Conclusion

The current research involved preparation and evaluation of herbal sunscreen made from flower extract of *Rhododendron barbatum*. Herbal sunscreens have become increasingly popular due to their natural character, safety, antioxidant properties, and fewer side effects than that of synthetic sunscreens. The hydro-alcoholic flower extract of *Rhododendron barbatum* was obtained using maceration technique and underwent preliminary phytochemical screening. It was found that phytoconstituents such as flavonoids, phenolics, tannins, and saponins were present in the flower extract. These phytoconstituents are reported for their antioxidant and photoprotective effects. Three

formulations of herbal sunscreen lotion, i.e., F1, F2, and F3 were prepared using different concentrations of flower extracts and evaluated for various physicochemical parameters. All the formulations prepared showed satisfactory physical characteristics including texture, consistency, and uniformity. The pH levels of all the formulations were found within the appropriate level for topical skin application, implying that it is compatible with skin and hence unlikely to cause any irritation. Of all formulations, formulation F3 had the best evaluation results. Formulation F3 had good homogeneity, high spreadability, good washability, and high stability without any signs of phase separation. Studies through patch tests revealed that the formulation was non-irritant and could be safely used topically because there were no signs of redness, itching, or swelling when applied on the skin. Results from UV spectrophotometry analysis and SPF estimation using Mansur equation suggested that formulation F3 has an SPF value of 8.36, which shows its good SPF properties against harmful UV radiation. The conclusion made based on this study is that the developed herbal sunscreen cream formulation has acceptable physical stability, safety, and SPF properties. This is due to the presence of bioactive compounds responsible for their sun screening and antioxidative effects. Hence, this formulation can be used safely to protect skin against damaging effects of UV radiation.

REFERENCE

1. J. D'Orazio, S. Jarrett, A. Amaro-Ortiz, and T. Scott, "UV Radiation and the Skin," *Int. J. Mol.*

- Sci., vol. 14, no. 6, pp. 12222–12248, Jun. 2013, doi: 10.3390/ijms140612222.
2. S. Ito, K. Wakamatsu, and H. OZEKI, “Chemical Analysis of Melanins and its Application to the Study of the Regulation of Melanogenesis,” *Pigment Cell Res.*, vol. 13, no. s8, pp. 103–109, Jun. 2000, doi: 10.1034/j.1600-0749.13.s8.19.x.
3. J. D’Orazio, S. Jarrett, A. Amaro-Ortiz, and T. Scott, “UV Radiation and the Skin,” *Int. J. Mol. Sci.*, vol. 14, no. 6, pp. 12222–12248, Jun. 2013, doi: 10.3390/ijms140612222.
4. A. R. Young, J. Claveau, and A. B. Rossi, “Ultraviolet radiation and the skin: Photobiology and sunscreen photoprotection,” *J. Am. Acad. Dermatol.*, vol. 76, no. 3, pp. S100–S109, Mar. 2017, doi: 10.1016/j.jaad.2016.09.038.
5. A. AHMADY, M. H. AMINI, A. M. ZHAKFAR, G. BABAK, and M. N. SEDIQI, “Sun Protective Potential and Physical Stability of Herbal Sunscreen Developed from Afghan Medicinal Plants,” *Turk. J. Pharm. Sci.*, vol. 17, no. 3, pp. 285–292, Jun. 2020, doi: 10.4274/tjps.galenos.2019.15428.
6. U. Rawat *et al.*, “Triterpenoidal saponin and phenolic glycosides from *Rhododendron barbatum* flowers,” *Medicinal Plants - International Journal of Phytomedicines and Related Industries*, vol. 3, no. 1, p. 73, 2011, doi: 10.5958/j.0975-4261.3.1.010.
7. B. Chaurasia, A. Pandey, and L. M. S. Palni, “Distribution, colonization and diversity of arbuscular mycorrhizal fungi associated with central Himalayan rhododendrons,” *For. Ecol. Manage.*, vol. 207, no. 3, pp. 315–324, Mar. 2005, doi: 10.1016/j.foreco.2004.10.014.
8. R. Mewada and Y. Shah, “Preparation and evaluation of herbal sunscreen creams,” *International Journal of Pharmaceutical Chemistry and Analysis*, vol. 10, no. 2, pp. 116–124, Jul. 2023, doi: 10.18231/j.ijpca.2023.021.
9. S. Rohmani, L. Mar’atushsholihah, U. A. Darojati, A. D. Meitasari, and B. N. A. Susanto, “Formulation and Activity of Sunscreen Cream from Ethanol Extract of *Calendula officinalis* L Flowers,” *Jurnal Sains Farmasi & Klinis*, vol. 11, no. 1, pp. 48–57, Jun. 2024, doi: 10.25077/jsfk.11.1.48-57.2024.
10. M. M. Donglikar and S. L. Deore, “Development and Evaluation of Herbal Sunscreen,” *Pharmacognosy Journal*, vol. 9, no. 1, pp. 83–97, Nov. 2016, doi: 10.5530/pj.2017.1.15.
11. Rozinaparvin Iqbal Patel, Aarifa Mustak Patel, and Bhavyaben Dharmeshkumar Modi, “Formulation and evaluation of herbal sunscreen,” *World Journal of Biology Pharmacy and Health Sciences*, vol. 13, no. 2, pp. 029–040, Feb. 2023, doi: 10.30574/wjbphs.2023.13.2.0061.
12. W. Chaiyana, G. Liang, J. Inthorn, and P. Chomchalao, “Cricket Oil-Based Sunscreen Systems: Formulation Design, Ultraviolet Protection Performance, and Preclinical Safety Evaluation,” *Pharmaceutics*, vol. 18, no. 3, p. 325, Mar. 2026, doi: 10.3390/pharmaceutics18030325.
13. M. Špaglová, P. Čermáková, P. Jackuliaková, and J. Piešťanský, “Role of Emulsifiers and SPF Booster in Sunscreen Performance: Assessing SPF, Rheological Behavior, Texture, and Stability,” *Cosmetics*, vol. 12, no. 3, p. 118, Jun. 2025, doi: 10.3390/cosmetics12030118.
14. L. Yarovaya, N. Waranuch, W. Wisuitiprot, and W. Khunkitti, “Chemical and mechanical accelerated and long- term stability evaluation of sunscreen formulation containing grape seed extract,” *J. Cosmet. Dermatol.*, vol. 21, no. 11, pp. 6400–6413, Nov. 2022, doi: 10.1111/jocd.15308.
15. G. Nabiyeva, B. Teoman, A. Potanin, and G. Y. Gor, “Sunscreen sensory attribute prediction via textural, rheological and tribological tests,” *Int. J. Cosmet. Sci.*, vol. 48, no. 1, pp. 97–109, Feb. 2026, doi: 10.1111/ics.70021.

16. E. Yulianti, W. Warsito, A. Sabarudin, B. Muchtarohmah, T. A. Wahyuningtyas, and O. V. Velya, "Development of High-SPF Sunscreen Cream Formulation Using Green Tea (*Camellia sinensis*L.) Extract Obtained via Combined Pulsed Electric Field and Microwave–Ultrasound Assisted Extraction (PEF-MUAE)," *journal of pure and applied chemistry research*, vol. 14, no. 2, pp. 67–79, Aug. 2025, doi: 10.21776/ub.jpacr.2025.014.02.7949.
17. N. R. Kusuma, N. Sulistyani, and N. Sugihartini, "Evaluation of Skin Irritation Potential of a Butterfly Pea (*Clitoria ternatea*) Extract Sunscreen Spray Using the Patch Test Method," *Journal of Pharmaceutical and Sciences*, pp. 1355–1361, May 2026, doi: 10.36490/journal-jps.com.v9i2.1281.
18. M. A. Khan, "SUN PROTECTION FACTOR DETERMINATION STUDIES OF SOME SUNSCREEN FORMULATIONS USED IN COSMETICS FOR THEIR SELECTION," *Journal of Drug Delivery and Therapeutics*, vol. 8, no. 5-s, pp. 149–151, Oct. 2018, doi: 10.22270/jddt.v8i5-s.1924.

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