DOI: https://doi.org/10.52756/ijerr.2023.v30.017 *Int. J. Exp. Res. Rev.*, Vol. 30: 179-189 (2023)

Original Article | Peer Reviewed | Open Access

International Journal of Experimental Research and Review (IJERR)

ISSN: 2455-4855 (Online)
www.iaph.in
ISSN 2455-4855

Assessment of the SPF and Anti-Irritating Properties of Sunscreen designed for Retinol users

Pritipadma Panda[1*], Saimanisha Muppidi[2], Kartheswari Karuturi[3], Meghana Reddy Moranganti[4] and Sandeep Mukkamala[5]

[1]Head of Research and Development Department, Esthetic Insights, Jeedimetla, Hyderabad, 500055, India; [2]Senior Research Executive, Esthetic Insights, Jeedimetla, Hyderabad, 500055, India; [3]Senior Research Executive, Esthetic Insights, Jeedimetla, Hyderabad, 500055, India; [4]Research Coordinator, Esthetic Insights, Jeedimetla, Hyderabad, 500055, India; [5]Chief Research and Development Officer, Esthetic Insights, Jeedimetla, Hyderabad, 500055, India

E-mail/Orcid Id:

PP, pritipadma@estheticinsights.com, https://orcid.org/0000-0002-1185-9545; *SM,* manisha@estheticinsights.com, https://orcid.org/0009-0002-8320-975X; *KK,* karthe@estheticinsights.com, https://orcid.org/0009-0002-9215-7672; *MRM,* meghanareddy@estheticinsights.com, https://orcid.org/0009-0008-2976-5679; *SM,* sandeep@estheticinsights.com, https://orcid.org/0009-0006-6145-602X

Article History:

Received: 24th Feb., 2023
Accepted: 10th Apr., 2023
Published: 30th Apr., 2023

Keywords:
Retinol, SPF, Sunscreen, Sensitive Skin, UVA, UVB

Abstract: Vitamin A and its derivatives, also known as retinoids, when applied topically for anti-ageing benefits, typically cause erythema and dryness on the skin, which are considered significant and common side effects. Furthermore, users of topical retinoids, like everyone else, need a sunscreen that protects the skin from harmful sun exposure while simultaneously countering the erythema and dryness of the skin. Retinoids also enhance the rate of skin cell turnover and expose newly produced skin to solar exposure, increasing the risk of sun damage and hyperpigmentation. Since the skin becomes sensitive with topical retinoids, a sunscreen must possess the further benefit of elevated skin resilience, which is much needed with conventional sun protection. ‘‘EI Pro Retinol Sunscreen’’ came up with a new innovative sunscreen with UV protectants and other active ingredients that have calming and soothing properties that minimize erythema and dryness. EI launched the “EI PRO Retinol series,” which includes the “EI PRO Retinol Sunscreen,” to protect the skin from the detrimental effects of ultraviolet rays as well as further irritation and itching caused by retinoid actions on the skin. In this study, researchers attempted to develop and design a sunscreen using a patented sunscreen agent (a combination of water, ethylhexyl methoxy-cinnamate, butyl methoxy-dibenzoyl-methane, benzophenone-3, phospholipids, and 1,3-butylene glycol) and Porphyridium cruentum (marine algae) for skin resilience, antioxidants like ascorbic acid, vitamin E, and soothing agents like carrot seed oil and sodium hyaluronate. Sunscreens are evaluated based on their sun protection factor (SPF), PA rating, and critical wavelength. Usually, sunscreens with an SPF above 50, a PA rating of ++++, and a critical wavelength over 370 nm would offer higher sun protection and block both UVA and UVB rays. The results showed that “EI PRO Retinol Sunscreen” has a critical wavelength of 376.67 and is considered a broad-spectrum SPF 50 PA++++ sunscreen. Thus, ‘‘EI PRO Retinol Sunscreen’’ is also proven to be safe on the skin without irritation, and it is proven to be non-irritant by a single, blinded patch test method.

Introduction

Humans are generally exposed to natural background radiation like visible, ultraviolet (UV), and infrared light (Zamanian and Fluor, 2005). UV radiation damages the skin acutely and chronically, and based on wavelength, UV rays can be divided into three main groups: UVA, UVB, and UVC rays (Sharma and Sharma, 2022). The stratospheric ozone layer mostly blocks UVC radiation

***Corresponding Author:** pritipadma@estheticinsights.com

(200–280 nm), UVB radiation (280–320 nm) is mostly absorbed by the epidermis, and UVA radiation (320–400 nm) penetrates much deeper into the dermis but also comes into contact with the stratum corneum (SC) as the well as epidermis (Biniek et al., 2012). When UVB radiation penetrates the skin, it causes sunburns, erythema, and skin tanning (Moore, 2013). UVA light exposure can induce skin cancer and irreversible elasticity deterioration (Harrison and Bergfeld, 2009). UVB rays represent less than 5% of terrestrial UVR but have much more severe effects than UVA. UVA is constant throughout the day, although UVB peaks about noon (Young, 2006). Sunscreen contains molecular complexes that absorb, reflect, or scatter UV spectra (Gonzalez et al., 2008). To prevent skin concerns, sunscreen should block the full UVB and UVA spectrum. It should be safe, chemically inert, non-irritating, non-toxic, photostable, and completely protect skin from UV rays. It's important not to block UVR's benefits, such as vitamin D production (Young, 2006). Chemical or organic sunscreen absorbs UV radiation by transforming it into heat energy, minimising its detrimental effects and the depth to which it can penetrate the skin, whereas physical or inorganic sunscreens block UV rays by creating a coating that prevents solar rays from permeating the skin (Geoffrey et al., 2019). Chemical sunscreens mainly include Ethylhexyl Methoxycinnamate (EHMC), Butyl Methoxy-dibenzoyl-methane (BMDBM) or Avobenzone (Siller et al., 2018). Physical sunscreen primarily includes titanium dioxide and zinc oxide (Ekstein and Hylwa, 2023). Chemical sunscreens combine with various chemical filters to provide broad-spectrum UVA/UVB protection (Kai et al., 2016).

Studies on animals and clinical work on humans suggest that UVR doses are high enough to cause cutaneous erythema, according to Alhansaniah et al. (Alhasaniah et al., 2019). The epidermis, the outermost protective layer of skin, consistently renews and differentiates. Furthermore, it serves as a barrier against the environment and is promptly affected by UV radiation. The epidermis is composed of four types of cells: keratinocytes (90%), melanocytes, Langerhans cells, and Merkel cells. Keratinocytes use the stratum corneum (SC) to form a water barrier in the epidermal basal layer, and tight junctions form a barrier in the stratum granulosum (Kubo et al., 2012). The SC, the outer layer of the epidermis, absorbs almost all UVB. UV exposure causes severe damage to the SC, including uneven and dry texture, reduced epithelial tissue and barrier function, and negative effects on cellular cohesion. Clinical studies demonstrated a consistent decrease in epidermal thickness in UV-exposed areas (Domyati et al., 2002). Acute UV exposure promotes keratinocyte proliferation by activating the epidermal growth factor receptor (EGFR), whereas chronic UV exposure intensifies ageing by making the epidermis thinner (Ansary, 2021). Individuals with light skin pigmentation and sensitive skin are more susceptible to UV damage because UV rays can easily penetrate the epidermis and affect both keratinocytes and melanocytes in the deeper epidermal layers (Geoffrey et al., 2019).

It is known that retinoids are unstable when exposed to sunlight or heat. UVB and UVA rays diminish the amount of vitamin A in the human epidermis (Carlotti et al., 2002). UV radiation increases collagen degradation, alters collagen synthesis, and modifies elastin fibres. In the absence of both collagen and elastin, the skin loses its elasticity and strength. Additionally, the skin's self-repair capacity also declines with age (Shanbhag et al., 2019). Thus, photodamaged skin contributes to loss of skin elasticity, skin roughness and dryness, uneven pigmentation, and deep wrinkles (Makrantonaki et al., 2007). Therefore people on a retinoid regimen should use a stable, non-irritant, broad-spectrum SPF 50+ sunscreen that is suitable for inflamed and dry skin. Thus, EI introduced the "EI PRO Retinol series," which includes the "EI PRO Retinol Sunscreen," to protect the skin from the negative effects of UV rays and further irritation and drying. "EI PRO Retinol Sunscreen" is recommended to be used during the day and reapply for every four hours till evening, while "EI PRO Retinol Serums" are recommended to be taken at night, followed up by moisturiser for greater penetration.

The test procedure that is designed to determine the Sunscreen PA rating and in vitro protection factor is based on determining the amount of UV light that can be transmitted through a thin film of sunscreen sample that has been spread over a roughened substrate prior to and thereafter being exposed to a regulated amount of radiation from a specified UV exposure source. This is done to determine the amount of UV light that can be transmitted through the sunscreen sample. Since there are several variables that cannot be controlled with normal thin film spectroscopic methods, every set of data on the transmission of sunscreen is numerically adjusted so that the in vitro SPF data provide the same measured in vivo SPF value that was found by in vivo testing. As some Retinol users are prone to itching and redness (erythema, edema), this sunscreen has been developed to resolve the above issues caused by Retinol by adding antioxidants, as determined by the anti-irritancy test using the single-application patch test method on human volunteers.

DOI: https://doi.org/10.52756/ijerr.2023.v30.017

Materials and Methods

To calculate the percentage of light that passes through a specific wavelength, the equipment UV-2000S utilizes an integrating sphere and two spectrometers to measure transmittance across the wavelength range from 250 to 450 nm. The integrating sphere's sample beam is created by an ultraviolet-pulsed flash lamp (Hubner et al., 2020), as shown in figure 1.

A balance, a solar simulator, and UV 2000S ultraviolet transmittance analyzer were the instruments utilised to test the SPF. Solvents include glycerin and distilled water. Equipment included 3M Transpore tape, a pipette, and tissue paper.

Analysis Procedure

The analysis procedure for blank and sample plate preparation was followed by Khunkitti Watcharee et al. with slight modifications (Khunkitti et al., 2014).

Blank Plate Preparation

The 3M Transpore tape was clipped to the appropriate size to adhere to the PMMA plate. This was then placed rough side up on the analytical balance, and the weight was recorded. Using a pipette, sprinkle small droplets of glycerine evenly across the substrate's roughened surface until the glycerine's total weight is 15µl for a 50 × 50 mm plate. The plate containing the tape was removed from the analytical balance, and glycerine was quickly and evenly applied across the whole surface of the plate with a finger using light strokes. The surface of the plate was brushed in every direction until there were no more droplets or places with an excess agent. A period of fifteen minutes was provided for the plate to rest in a dimly lit area. The plate containing the Transpore tape was subsequently scanned, and the transmittance statistics were compared to the table below. After achieving the transmittance limit, a blank scan was taken, and the sample plate was prepared.

Sample plate preparation

The weight of the Transpore tape attached to a PMMA plate was recorded using an analytical balance. A pipette added small droplets of the sample to the clean plate at 1.3 mg/cm2, which is 32.5 mg for a 50 × 50 mm plate. After removing it from the analytical balance, the sample was spread evenly across the plate with a pre-saturated finger. Spreading was accomplished in two phases. First, the product was spread quickly (less than 30 seconds) over the whole area with small circular motions and low pressure. Alternating horizontal and vertical strokes with moderate pressure was used to rub the sample on the plate. The second phase lasted for 20-30 seconds. When the sample was spread evenly without gaps, smears, or excess product deposition, it was allowed to equilibrate for 15 minutes in the dark at ambient temperature to form a standard stabilised product film.

UV exposure using a solar simulator (UV source)

During UV exposure, treated Transpore tape was placed on a non-reflective surface. The total UV irradiation was between 50 and 140 Wm-2. During one measurement cycle, the UV dosage provided did not exceed 0.2 J/cm2. In the solar simulator, the sample plate was exposed.

Operating Procedure

The blank plate was initially scanned using the UV2000S transmittance analyzer. The sample plate was subsequently scanned to determine the pre-irradiation SPF. This was followed by irradiating the plate in a solar simulator. Additional sample plates were scanned to determine the post-irradiation SPF.

Calculations

Sunscreen Protection Factor (SPF)

SPF is a measurement of the amount of UV solar energy required to cause sunburn on skin treated with sunscreen as compared to the amount of solar energy required to cause sunburn on skin without protection. Most of the time, erythema caused by UV radiation can be stopped by using sunscreen with a high SPF value. The formula for finding the minimal erythematous dose of sun protection factor is given below:

SPF = MED protected skin / MED Unprotected skin

There is a common misunderstanding that one factor that determines SPF is the amount of time spent in the sun, but it rather depends on the amount of UV exposure. This is how protection levels are shown in various places. Less than 15 are considered low sun protection, SPF between 15–29 is medium, SPF 30–49 is high, and SPF 50+ is excellent (Mohanty et al., 2022).

As the SPF value of sunscreen increases, so does its sunburn protection. Most sunscreen manufacturers use an in vitro method comparable to the UV-2000S UV light test to accelerate new product development, reduce in vivo product testing cycles and costs, and check manufacturing consistency from lot to lot. UV-2000 determines the SPF characteristic based on the ratio.

$$SPF = \frac{\int_{320}^{400} E\lambda\, S\lambda\, d\lambda}{\int_{320}^{400} E\lambda\, S\lambda\, T\lambda\, d\lambda}$$

Where Eλ is the erythema action spectrum, Sλ denotes the spectrum irradiance of the sun, and the spectral transmission of the sample is denoted by Tλ, with the total being calculated throughout the wavelength limitations of 290 to 400 nm.

DOI: https://doi.org/10.52756/ijerr.2023.v30.017

UVAPF0

The pre-irradiation UVA Protection Factor, abbreviated as UVAPF0, is something that is calculated for each plate on an individual basis. The in vitro SPF sunscreen feature mentioned earlier is adjusted to the in vivo SPF value established for the same sunscreen product. This is done to calculate the coefficient of adjustment, which is denoted by the letter C. The value of the Coefficient of Adjustment C is calculated automatically by UV-2000, and then it is applied to the ratio. Where P(A) represents the action spectrum for PPD given in the guidelines. According to the COLIPA Method, C should vary between 0.8 and 1.2. Before irradiating the sample, the UVAPF0 is determined and displayed in the Plate Data Table under the name "UVAPF Pre-irradiation" (Matts et al., 2010).

$$\text{UVAPF}_0 = \frac{\int_{320}^{400} P(\lambda)I(\lambda)d\lambda}{\int_{320}^{400} P(\lambda)I(\lambda)10^{-A_0[\lambda]C}\,d\lambda}$$

UVAPF

The UVAPF characteristic is calculated similarly to UVAPF0, except that the computation is performed after the irradiance has been applied to the sample plate. In both calculations, the coefficient C has the same value. UV-2000 displays the UVAPF value for each plate in the Plate Data Table, under the name "UVAPF."

Irradiation Dose: After the pre-irradiation scans are complete, the irradiation dosage is determined for each sample plate. The dosage parameter equals the UVAPF0 parameter multiplied by 1,2 J/cm2.

Mean UVAPF

UV-2000 determines the mean UVAPF value of the involved plates and displays it in the bottom-right corner of the COLIPA Method Window as "UVAPF Mean." Until sufficient sample plates have been analysed, the characteristic is not displayed.

SPF:UVAPF Ratio

Under the COLIPA procedure, the ultimate sunscreen characteristic is the SPF:UVAPF Ratio, which is the in vivo SPF or SPF label parameter divided by the UVAPF mean.

Critical wavelength (λc)

The following relation is used to identify the crucial wavelength across the spectrum ranging from 290 to 400 nm: λc = Min(A′), such that λ satisfies the relationship:

$$\frac{\sum_{\lambda=290}^{\lambda'} = A_\lambda}{\sum_{\lambda=290}^{400} = A_\lambda} \geq 0.9$$

where A(λ) is the absorbance at wavelength λ (Donglikar and Deore, 2016).

The computed sun protection factor (SPF) and the crucial wavelength are displayed in the data window of UV-2000 for the scan selected in the Scan Sets Window. When calculating the mean statistics, the whole set that corresponds to the scan or set that is selected in the Scan Sets Window is considered:

$$\text{SPF Mean} = \sum_{i=1}^{n} \frac{SPF(i)}{n},$$

$$Lambda\ Critical\ Mean = \sum_{i=1}^{n} \frac{\lambda_c(i)}{n}$$

The statistics regarding the standard deviation are computed for the full set that corresponds to the scan or set that is selected in the Scan Sets Window:

$$\text{SPF STD} = \sqrt{\sum_{i=1}^{n} \frac{(SPF(i) - SPF\ mean)^2}{n-1}}$$

$$\text{Lambda Critical STD} = \sqrt{\sum_{i=1}^{n} \frac{(\lambda c(i) - Lamda\ Critical\ Mean)^2}{n-1}}$$

The coefficient of variation is defined for each set as:

$$\text{COV} = \frac{SPF}{Mean} 100\%$$

UVA: UVB Ratio

This ratio is a property of sunscreen that is estimated based on both pre-exposure and post-exposure conditions:

$$\text{UVA:UVB Ratio} = \frac{\text{UVA}}{\text{UVB}}$$

For each sample plate, UV-2000 shows the UVA: UVB Ratio both prior to and after the UV exposure.

In vitro SPF obtained for ‘‘EI PRO RETINOL SUNSCREEN’’ with batch no. EIPRS is 52.23 and boost star is ***.

Irritancy study by single application patch test method

The "EI Pro Retinol" sunscreen skin sensitization study is conducted using a single application patch test method. 12 women and 12 men, healthy human volunteers were chosen between 18 and 54 for a single-site, non-randomised trial in which a closed, occlusive patch was then taped onto the back of the subject, between the scapula and waist, for 8 days.

The procedure for patch preparation of product is followed as per the BIS Standard clause 4.3.1.2, IS 4011:2018, 3rd Revision. Patch preparation for negative control as per BIS Standard clause 4.3.1.2.4, IS 4011:2018, 3rd revision, i.e., 0.9% isotonic saline solution and patch preparation for Positive control as per BIS Standard clause 4.3.1.2.4, IS 4011:2018, 3rd Revision, i.e., 1% w/w SLS solution in distilled water.

Mean Score for Irritation = Total score (Erythema + Oedema) for each sample / Total number of subjects.

DOI: https://doi.org/10.52756/ijerr.2023.v30.017

In accordance with Clause 4.3.1.3 Observation and Scoring for Skin Irritancy Test, the Draize Scale for having scored the treatment sites (IS 4011:2018, Methods of Test for Safety Assessment of Cosmetics - Third Revision), the mean score of observations for evaluating skin irritation at the investigational site was measured. A mean score of 2.0 out of 8.0 is regarded as non-irritating, a score between 4.0 and 8.0 is considered mildly irritating, and a score between 4.0 and 8.0 is considered irritating (Draize et al., 1994).

Considerations Regarding Ethics and Law

The insurance number for the patch test study is (121200/48/2022/7027). Each subject signed their consent forms with complete understanding. In the testing laboratory the quality system was in complete compliance with ICH-E6 and good clinical practice (GCP) criteria. This study adhered to the most recent recommendations of the World Medical Association (Declaration of Helsinki, 1964, amended in Fortaleza, Brazil, 2013) in accordance with the "Drugs and Cosmetics Act Schedules."

Results

As shown in Table 1, from the preirradiation statistics study, the mean SPF value was found to be 52.33 from the total of three scans. Whereas the mean transmittance T (UVA) rays is found to be 10.51% and the mean transmittance T (UVB) 1.86%. Therefore, from the pre-irradiation statistics, it is shown that the mean UVA/UVB ratio is 0.782 and the mean critical wavelength (λc) is 377.00, which is clearly shown in figure 2. As shown in Table 2, from the post-irradiation statistics study, the mean SPF value is found to be 40.84 from the total of three scans. Whereas the mean transmittance T (UVA) rays is found to be 10.94% and the mean transmittance T (UVB) 2.37%. Therefore, from the post-irradiation statistics, it is shown in figure 3 that the mean UVA/UVB ratio is 0.852, with the mean critical wavelength λc is 376.67. From the total number of scans, it is found that the SPF value is 49.99, and from the mean value, it is found to be 55.56. By taking into consideration the standard deviation, the SPF mean is found to be 51.15, and according to the parameter coefficient of variation, the mean SPF is found to be 52.23, as shown in table 3. As per Table 4, in the ‘‘EI PRO Retinol sunscreen’’, the mean UVA/UVB ratio is greater than 1. Hence, the SPF boost star is ***. According to table 4, the Japanese PA method, more than 16 UVAPA values are PA++++, indicating a very high level of performance. Thus, the ‘‘EI PRO Retinol Sunscreen’’ has a critical wavelength of 376.67 and is considered a broad-spectrum SPF 50 PA++++ sunscreen with a boost star ***. As per Table 5, and the patch test results say that the dermatologists found no irritative response on T2 day (24 hours after patch removal). There was no reaction observed for the negative control (i.e., 0.9% isotonic saline solution), which was compared to the Mean Score of 2.1 for the positive control (1% w/w SLS solution). The overall mean score for both erythema and oedema was 0.0, which was clearly shown in table 6.

Table 1. Mean Pre-Irradiation Statistics

Parameters	SPF	T(UVA)	T(UVB)	Lambda Critical	UVA/UVB ratio
No. of Scans	03	03	03	03	03
Mean	52.33	10.51 %	1.86%	377.00	0.782
STD	2.89	0.35%	0.10%	0.00	-
COV	5.52	3.36%	5.16%	0.00%	-

Table 2. Mean Post-Irradiation Statistics

Parameters	SPF	T(UVA)	T(UVB)	Lambda Critical	UVA/UVB ratio
No. of Scans	03	03	03	03	03
Mean	40.84	10.94 %	2.37%	376.67	0.852
STD	3.73	0.54 %	0.20%	0.31	-
COV	9.14	4.19 %	8.33%	0.08%	-

Table 3. Final SPF Result

Parameters	SPF Mean	C Coeff	UVA PF	PA Rating	Boosts Star
No. of Scans	49.99	1.03	31.84	PA++++	***
Mean	55.56	1.00	33.53	PA++++	***
STD	51.15	1.02	34.13	PA++++	***
COV	52.23	1.02	33.17	PA++++	***

DOI: https://doi.org/10.52756/ijerr.2023.v30.017

Table 4. The average protection grade of UVA according to the Japanese PA rating method

UVAPF Value	2 to less than 4	4 to less than 8	8 to less than 16	More than 16
Japanese PA method	PA+	PA++	PA+++	PA++++
Level of performance	Low	Medium	High	Very High

Table 5. The Mean UVA:UVB ratio for sample plate before and after the ultraviolet radiation exposure

		INITIAL Mean UVA: UVB RATIO			
		0.0 to 0.59	0.6 to 0.79	0.8 to 0.89	0.9 and over
	0.0 to 0.56	No Rating	No Rating	No Rating	No Rating
POST EXPOSURE Mean UVA: UVB RATIO	0.57 to 0.75	No Rating	***	***	***
	0.76 to 0.85	No Rating	***	***	***
	0.86 and over	No Rating	***	***	***

Table 6. The Mean score of Erythema and Oedema for EI Pro Retinol Sunscreen

Test material	Total Score for Erythema	Total Score for Oedema	Total Score for Erythema+ Oedema	Mean Score (irritation)	Conclusion on the Irritation Assessment
EI PRO Retinol Sunscreen	1.0	0.0	1.0	0.0	Non-Irritant
Negative Control (0.9% Isotonic saline solution)	0.0	0.0	0.0	0.0	-
Positive Control (1% w/w SLS)	43.3	8.0	51.0	2.1	-

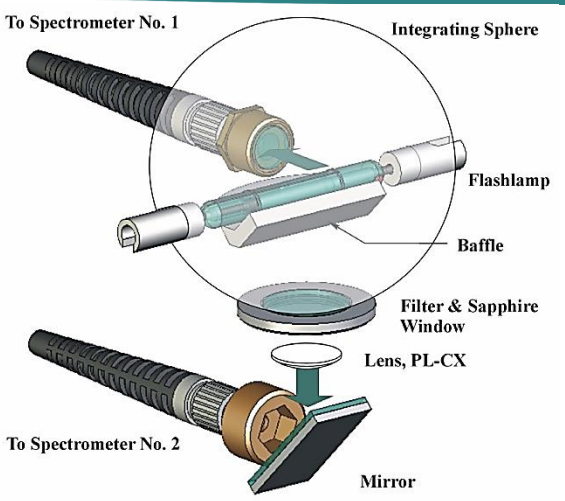


Figure 1. Instrument used for UV visible spectroscopy

Discussion

As the results suggested, the observed non-irritant behaviour of "EI Pro Retinol sunscreen" may be attributable to the addition of synergistic active ingredients to the formulation, which is elaborately discussed in the following discussion. ‘‘EI PRO Retinol Sunscreen’’ contains broad spectrum photoprotectants like ethylhexyl methoxycinnamate (EHMC), methoxydibenzoylmethane (BMDBM) or Azobenzone, benzophenone-3, or oxybenzone, moisturizing agent like hyaluronic acid (sodium hyaluronate), and natural antioxidants like vitamin C (3-o-ethyl ascorbic acid), vitamin E (tocopheryl acetate) and carrot seed oil. It also contains a bioactive, patented additive, Porphyridium cruentum extract that boosts the SPF. Octyl methoxy-cinnamate (OMC) and butyl methoxy-dibenzoyl-methane (BMDBM) are some of the most prevalent UV filters found in cosmetic sunscreens (Montenegro & Santagati, 2019). Ethylhexyl methoxy-cinnamate (EHMC) filters UVB, while butyl methoxydibenzoylmethane (BMDBM) filters UVA. Both are often added to sunscreen to protect the skin from the harmful effects of UV radiation from the sun (Scalia et al., 2011). "EI PRO Retinol sunscreen" has several soothing and moisturising actives since benzophenone-3 or oxybenzone (UVA, UVB and UVC filter) may be allergic to sensitive skin (Santagati et al., 2009). Butyl methoxy-dibenzoyl-methane significantly inhibits the production of free radicals caused by UV exposure. It is claimed to be photostable, reduce erythema, have anti-ageing properties, and support the skin's antioxidant defence system. Studies have revealed that this novel chemical provides protection against self-tanning (Latha et al., 2013).

DOI: https://doi.org/10.52756/ijerr.2023.v30.017

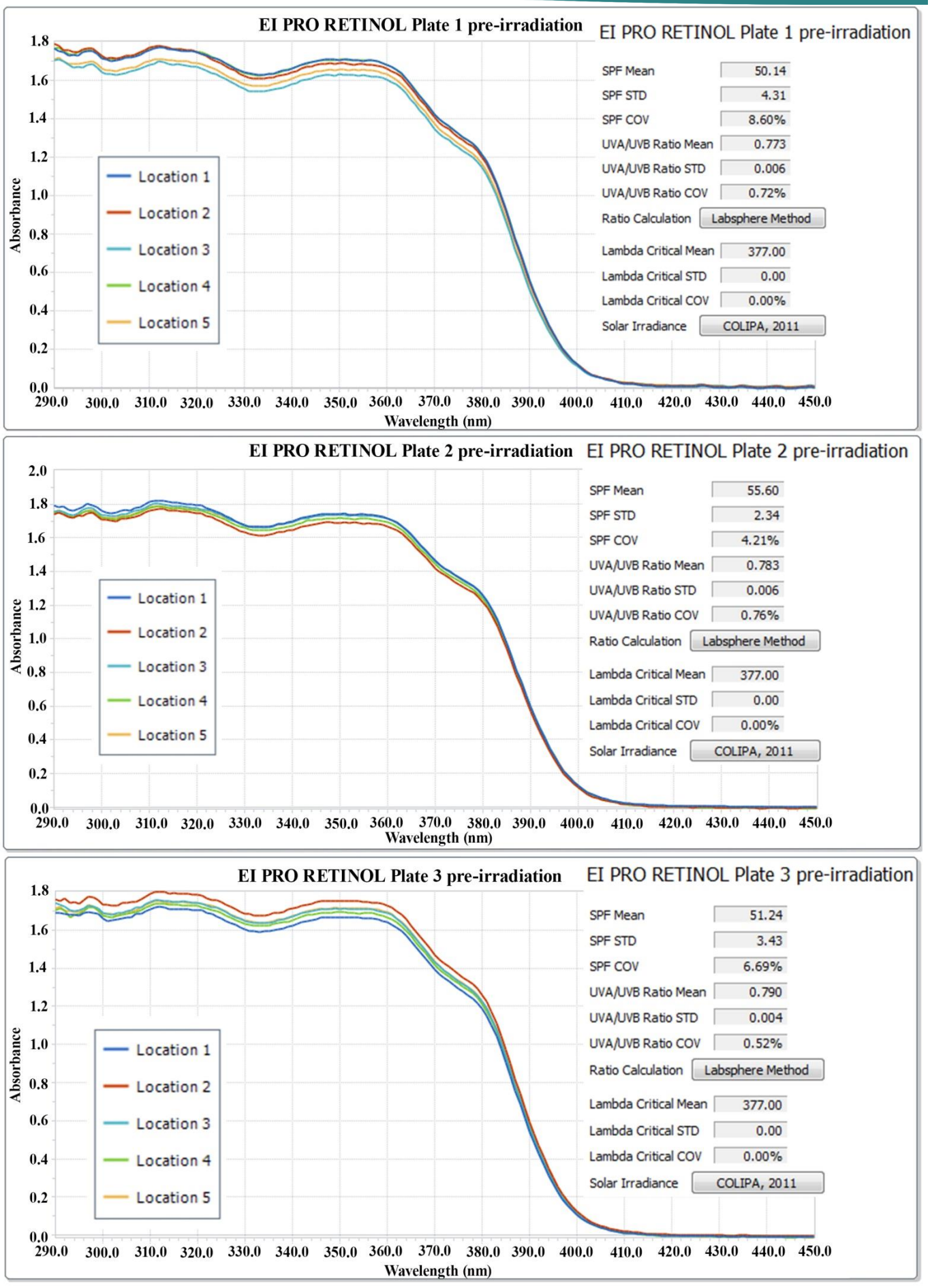
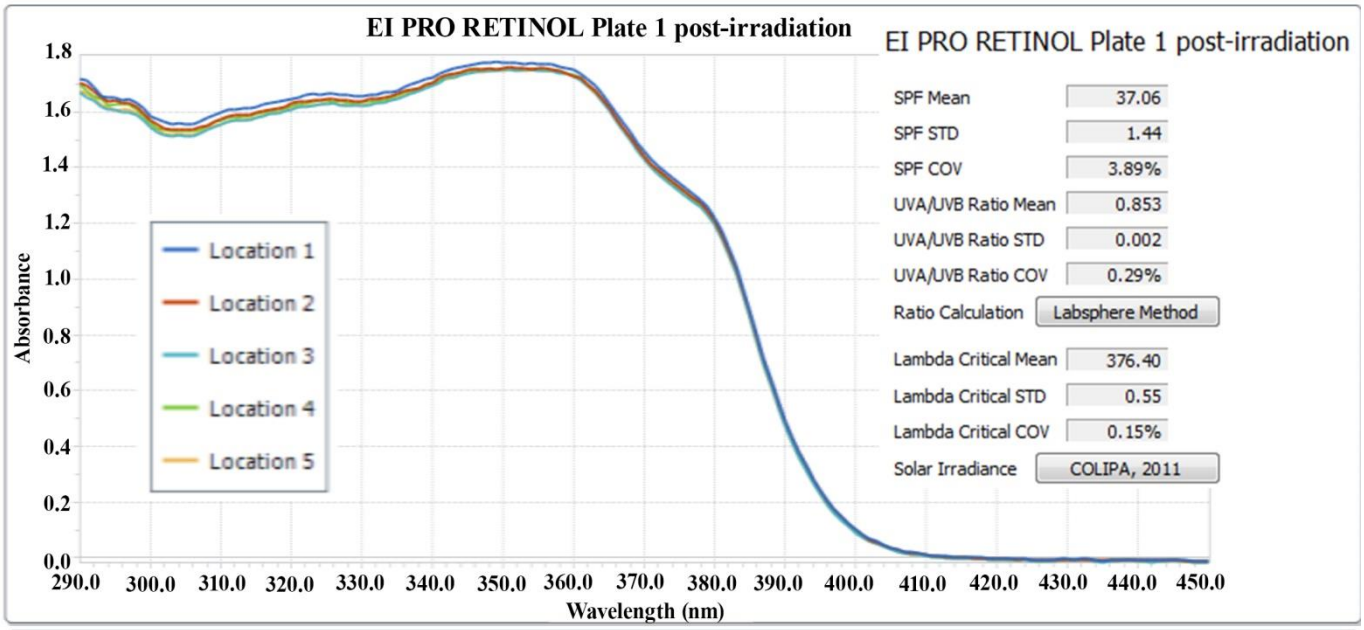
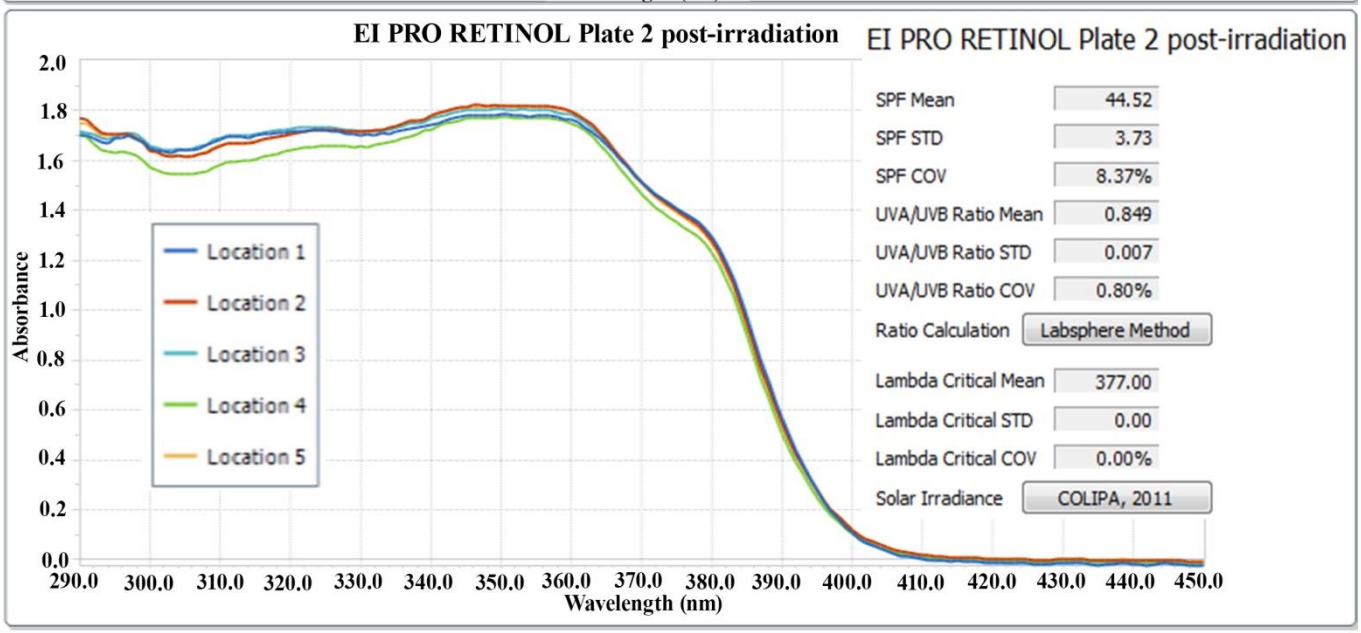


Figure 2. Graphical representation of EI PRO Retinol Sunscreen plate 1, 2 and 3 pre-irradiation data

DOI: https://doi.org/10.52756/ijerr.2023.v30.017





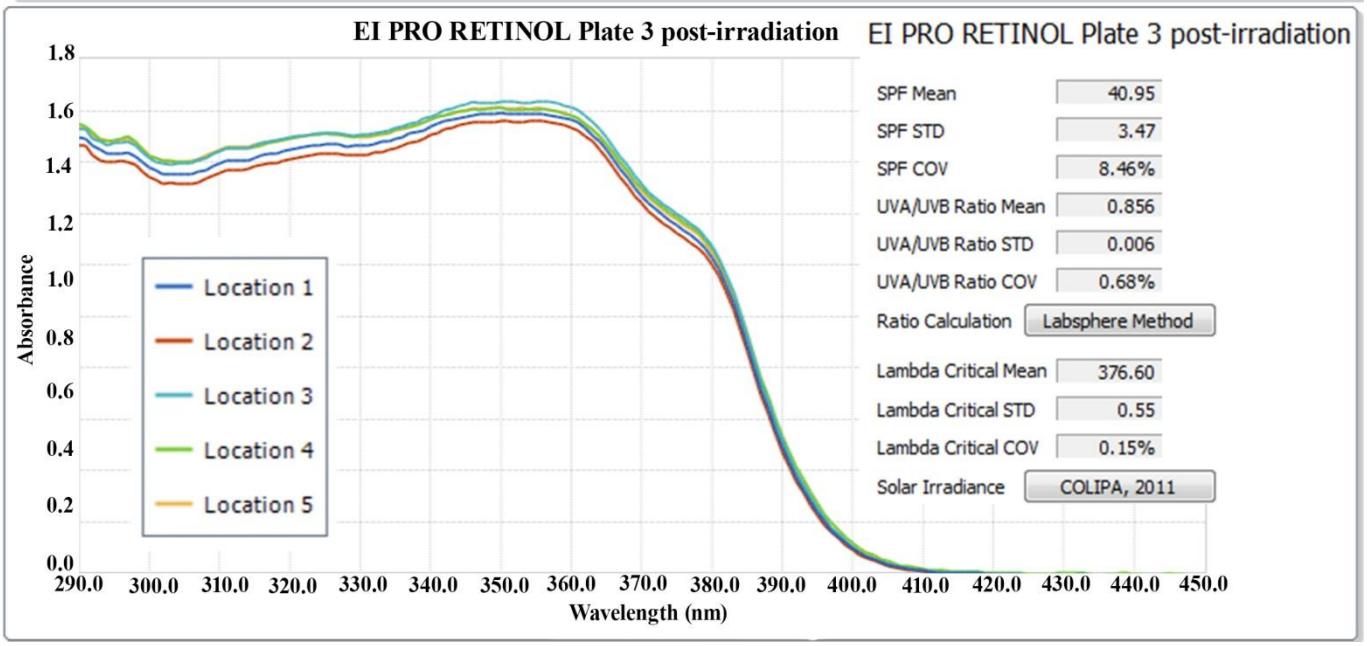


Figure 3. Graphical representation of EI PRO Retinol Sunscreen plate 1, 2 and 3 post-irradiation data

DOI: https://doi.org/10.52756/ijerr.2023.v30.017

The primary function of hyaluronic acid is to maintain skin moisture and suppleness. As Shreya Shanbhag et al. (2019) mentioned, hyaluronic acid has also been extensively utilised as an anti-wrinkle treatment. Compared to monotherapy, including vitamins C and E in sun blockers dramatically increase their photoprotective properties (Gonzalez et al., 2008). Vitamin E has been demonstrated to be effective in preventing photoaging and photo-carcinogenesis in various animal and human investigations (Guan, 2021). Tocopherol administered before and after UV exposure reduces erythema and sunburn damage, according to many studies said by Trevithick et al., (1992).

Bisset et al. (1990) found that applying antioxidants like tocopherol and ascorbate 2 hours before UVB exposure may prevent chronic skin damage (Trevithick et al., 1992). Vitamin C stimulates collagen and elastin synthesis pathways and decreases UV-induced skin photodamage (Pullar et al., 2017). ‘‘EI PRO Retinol Sunscreen’’ contains Suncat De, a gel-like substance, white in color, that contains Ethylhexyl Methoxycinnamate, Benzophenone-3, 1,3-Butylene Glycol, Phospholipids, Butyl Methoxydibenzoylmethane, and Water. That has superior broad-spectrum sun protection ability (Mohanty et al., 2022). Carrot (*Daucus carota*) seed oil is rich in vitamin A and possesses substantial antioxidant and vital aromatic characteristics. It can also protect the skin from the sun when it is applied topically to the skin as diluted carrier oil. Thus, it serves as a natural SPF booster (Goswami et al., 2013). *Porphyridium cruentum* is a species of red algae belonging to the family Porphyridiophyceae that shows a strong photoprotective capacity (Sun Protection Factor, SPF). Thus, *Porphydium cruentum* extract is incorporated to boost SPF (Gomez et al., 2019).

Conclusion

Based on the above results and discussion, it is proven that ‘‘EI PRO Retinol Sunscreen’’ is an effective broad-spectrum sunscreen with a high SPF and PA rating. The synergistic combination of calming and soothing ingredients and skin-nourishing vitamins might have significantly contributed to the achievement of zero irritancy in the ‘‘EI Pro Retinol Sunscreen". Thus, the concept of sunscreen use has shifted from merely preventing UV-induced erythema to providing broad-spectrum protection against erythema, photoaging, dyspigmentation, DNA damage, photo carcinogenesis, and moisturization due to the formulation of skin-nourishing vitamins with sunscreen agents.

Thus, ‘‘EI PRO Retinol Sunscreen’’ is said to be a broad-spectrum, non-irritating sunscreen that is suitable for dry, inflamed, and sensitive skin for people on retinol regimen.

Acknowledgement

I, Dr. Meghana Reddy Moranganti, vow that this submission is my original work and that, to the best of my knowledge, it has not been previously published anywhere. I also want to thank Dr. Nithar Ranjan Madhu (Editor of IJERR) for his patience in correcting the minor errors in the reference section and giving me time to complete this submission. The authors are indebted to Esthetic Insights Private Limited, Jeedimetla, Hyderabad, for providing laboratory facilities and financial support for this research. Mumbai-based Mascot Spin Control conducted the test procedure, and all the authors acknowledge Mascot Spin Control for conducting the research.

Conflict of Interest

The authors declare no conflict of interest.

References

Alhasaniah, A., Sheratt, M.J., & Oneill, C.A. (2019). The Impact of Ultraviolet Radiation on Barrier Function in Human Skin: Molecular Mechanisms and Topical Therapeutics. *Curr. Med. Chem.*, *25*(40), 5503-5511. https://doi.org/10.2174/0929867324666171106164916

Ansary, T.M., Hossain, R., Kamiya, K., Komine. M., & Ohtsuki, M. (2021). Inflammatory Molecules Associated with Ultraviolet Radiation-Mediated Skin Aging. *Int. J. Mol. Sci.*, *22*(8), 1-14. https://doi.org/10.3390/ijms22083974

Biniek, K., Levi, K., & Dauskardt, R.H. (2012). Solar UV radiation reduces the barrier function of human skin. *Proc. Natl. Acad. Sci.* (USA)., *109*(42), 17111–17116. https://doi.org/10.1073/pnas.1206851109

Bissett, D.L., Chatterjee, R., & Hannon, D.P. (1990). Photoprotective effect of superoxide-scavenging antioxidants against ultraviolet radiation-induced chronic skin damage in the hairless mouse. *Photodermatol Photoimmunol Photomed.*, *7*(2), 56-62.

Carlotti, M. E., Rossatto, V., & Gallarate, M. (2002). Vitamin A and vitamin A palmitate stability over time and under UVA and UVB radiation. *Int. J. Pharm.*, *240*(1-2), 85-94. https://doi.org/10.1016/S0378-5173(02)00128-X

Domyati, M.E.I., Attia, S., Saleh, F., Brown, D., Birk, D.E., Gasparro, F., Ahmad, H., & Uitto, J. (2002).

Intrinsic aging vs. photoaging: A comparative histopathological, immunohistochemical, and ultrastructural study of skin. *Exp. Dermatol.*, *11*(5), 398–405. https://doi.org/10.1034/j.1600-0625.2002.110502.x

Draize, J.H., Woodard, G., & Calvery, H.O. (1994). Methods for the Study of Irritation and Toxicity of Substances Applied Topically to the Skin and Mucous Membranes. *J. Pharmacol. Exp. Ther.*, *82*(3), 377-390.

Donglikar, M.M., & Deore, S.L. (2016). Sunscreens: A review. *Pharmacogn. J.*, *8*(3), 171-179. https://doi.org/10.5530/pj.2016.3.1

Ekstein, S.F., & Hylwa, S. (2022). Sunscreen: A Review of IV Filters and Their Allergic Potential. *Dermatitis*, 2022. https://doi.org/10.1097/DER.0000000000000963

Geoffrey, K., Mwangi, A.N., & Maru, S.M. (2019). Sunscreen products: Rationale for use, formulation development and regulatory considerations. *Saudi Pharm. J.*, *27*(7), 1009-1018. https://doi.org/10.1016/j.jsps.2019.08.003

Gomez, F.A., Korbee, N., Arrojo, V.C., Roberto, T. Diaz, A., and Figueroa, F.L. (2019). UV Photoprotection, Cytotoxicity and Immunology Capacity of Red Algae Extracts. *Molecules*, *24*(2), 1-16. https://doi.org/10.3390/molecules24020341

Gonzalez, S., Lorente, M.F., & Calzada, Y.G. (2008). The latest on skin photoprotection. *Clin. Dermatol.*, *26*(6), 614–626. https://doi.org/10.1016/j.clindermatol.2007.09.010

Goswami, P.K., Samant, M., & Srivastava, R. (2013). Natural Sunscreen Agents: A Review. *Sch. Acad. J. Pharm.*, *2*(6), 458-463.

Guan, L.L., Lim, H.W., & Mohammad, T.F. (2021). Sunscreens and Photoaging: A Review of Current Literature. *AM. J. Clin. Dermatol.*, *22*(6), 819-828. https://doi.org/10.1007/s40257-021-00632-5

Harrison, S.C., & Bergfeld, W.F. (2009). Ultraviolet light and skin cancer in athletes. *Sports Health*, *1*(4), 335–340. https://doi.org/10.1177/1941738109338923

Hubner, A.A., Sarruf, F.D., Oliveira, C.A., Neto, A,V., Fischer, D.C.H., Kato, T.M., Lourenco, f.R., Baby, A.R., & Bacchi, M. (2020). Safety and Photoprotective Efficacy of a Sunscreen System Based on Grape Pomace (*Vitis vinifera* L.) Phenolics from Winemaking. *Pharmaceutics*, *12*(12), 1-22. https://doi.org/10.3390/pharmaceutics12121148

Kai, D., Chua, Y. K., Jiang, L., Owh, C., Chan, S.Y., & Loh, X.J. (2016). Dual functional anti-oxidant and SPF enhancing lignin-based copolymers as additives for personal and healthcare products. *RSC Adv.*, *89*, 86420–86427. https://doi.org/10.1039/c6ra21433a

Kerr, A.C., Niklasson, B., Dawe, R.S., Escoffier, A.M., Krasteva, M., Sanderson ,B., and Ferguson, J. (2009). A double-blind, randomized assessment of the irritant potential of sunscreen chemical dilutions used in photopatch testing. *Contact. Derm.*, *60*(4), 203-209. https://doi.org/10.1111/j.1600-0536.2009.01516.x.

Khunkitti, W., Sattanakul, P., Waranuch, N., Pitaksuteepong, T., & Kitikhun, P. (2014). Method for screening sunscreen cream formulations by determination of in vitro SPF and PA values using UV transmission spectroscopy and texture profile analysis. *Int. J. Cosmet. Sci.*, *65*(3), 147-159.

Kubo, A., Nagao, K., & Amagai, M. (2012). Epidermal barrier dysfunction and cutaneous sensitization in atopic diseases. *J. Clin. Invest.*, *122*(2), 440–447. https://doi.org/10.1172/JCI57416

Latha, M.S., Martis, J., Shobha, V., Shinde, R.S., Bangera, S., Krishnankutty, B., Bellary, S., Varughese, S., & Rao, P. (2013). Sunscreening Agents: a review. *J. Clin. Aesthet. Dermatol.*, *6*(1), 16-26.

Makrantonaki, E., & Zouboulis, C.C. (2007). William J.Cunliffe Scientific Awards. Characteristics and pathomechanisms of endogenously aged skin. *Dermatology*, *214*(4), 352-360. https://doi.org/10.1159/000100890

Matts, P.J., Alard, V., Brown, M.W., Ferrero, L., Barlag, H.G., Issachar, N., Moyal, D., & Wolber, R. (2010). The Colipa in vitro UVA method: a standard and reproducible measure of sunscreen UVA protection. *Int. J. Cosmet. Sci.*, *32*(1), 35-46. https://doi.org/10.1111/j.1468-2494.2009.00542.x

Mohanty, S., Badhei, L., Pal. A., & Panda, P. (2022). Novel cosmeceutical formulations: a better approach to photoprotection. *Int. J. Appl. Pharm.*, *14*(4), 10-17. https://dx.doi.org/10.22159/ ijap.2022v14i4.44602

Montenegro, L., & Santagati, L.M. (2019). Use of Vegetable Oils to Improve the Sun Protection Factor of Sunscreen Formulations. *Cosmetics*, *6*(2), 1-10. https://doi.org/10.3390/cosmetics6020025

Moore, C., Cevikbas, F., Pasolli, H.A., Chen, Y., Kong, W., Kempkes, C., Parekh, P., Lee, S.H., Kontchou, N.A., Yeh, I., Jokerst, N.M., Fuchs, E., Steinhoff, M., & Liedtke W.B. (2013). UVB radiation generates sunburn pain and affects skin by activating epidermal TRPV4 ion channels and triggering endothelin-1 signaling. *Proc. Natl. Acad. Sci. U.S.A.*, *110*(34), 3225-3234.

https://doi.org/10.1073/pnas.1312933110

Pullar J.M., Carr, A.C., & Vissers, M.C.M. (2017). The Roles of Vitamin C in Skin Health. *Nutrients*, *9*(8),1-27. https://doi.org/10.3390/nu9080866

Shanbhag, S., Nayak, A., Narayan, R., & Nayak, U.Y. (2019). Anti-aging and Sunscreens: Paradigm Shift in Cosmetics. *Adv Pharm Bull.*, *9*(3),348-359. https://doi.org/10.15171/apb.2019.042

Scalia, S., Mezzena, M., & Ramaccini, D. (2011). Encapsulation of the UV filters ethylhexyl methoxycinnamate and butyl methoxy-dibenzoylmethane in lipid microparticles: effect on invivo human skin permeation. *Skin Pharmacol. Physiol.*, *24*(4), 182–189. https://doi.org/10.1159/000324054

Shanbhag, S., Nayak, A., Narayan, R., & Nayak, U.Y. (2019). Anti-aging and Sunscreens: Paradigm Shift in Cosmetics. *Adv Pharm Bull.*, *9*(3), 348-359. https://doi.org/10.15171/apb.2019.042

Sharma, M., & Sharma, A. (2023). A Review on Nature Based Sunscreen Agents. *Iop Conf. Ser.: Earth Environ. Sci.*, pp.1-11. https://doi.org/10.1088/1755-1315/1110/1/012047

Siller, A., Blaszak, S. C., Lazar, M., & Harken, E.O. (2018). Update about the Effects of the Sunscreen Ingredients Oxybenzone and Octinoxate on Humans and the Environment. *Plast Surg Nurs.*, *38*(4), 158-161. https://doi.org/10.1097/PSN.0000000000000244

Trevithick, J.R., Xiong, H., Lee, S., Shum, D.T., Sanford, S.E., Karlik, S.J., Norley, C., & Dilworth, G.R. (1992). Topical Tocopherol Acetate Reduces Post-UVB, Sunburn-Associated Erythema, Edema, and Skin Sensitivity in Hairless Mice. *Arch. Biochem. Biophys*., *296*(2), 575-582. https://doi.org/10.1016/0003-9861(92)90613-2

Young, A.R. (2006). Acute effects of UVR on human eyes and skin. *Prog. Biophys. Mol. Biol.*, *92*(1), 80-85. https://doi.org/10.1016/j.pbiomolbio.2006.02.005

Zamanian, A., & Fluor, C.Y. (2005). Electromagnetic Radiation and Human Health: A Review of Sources and Effects. *High Fre.*, pp.16-26.

How to cite this Article:

Pritipadma Panda, Saimanisha Muppidi, Kartheswari Karuturi, Meghana Reddy Moranganti and Sandeep Mukkamala (2023). Assessment of the SPF and Anti-Irritating Properties of Sunscreen designed for Retinol users. *International Journal of Experimental Research and Review*, *30*, 179-189.

DOI : https://doi.org/10.52756/ijerr.2023.v30.017