



INVITRO EVALUATION OF SUN PROTECTION FACTOR OF *PASSIFLORA EDULIS* LEAF EXTRACT BY USING UV SPECTROPHOTOMETER

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ABSTRACT

Prolonged exposure to ultraviolet (UV) radiation was a major contributor to erythema, photoaging, and other forms of skin damage, highlighting the need for effective and safer photoprotective agents. The present study evaluated the in vitro sun protection factor (SPF) of ethanolic leaf extracts of *Passiflora edulis* (purple variety) and *Passiflora edulis* f. *flavicarpa* (yellow variety) using UV spectrophotometric analysis. Dried leaves were defatted and subjected to Soxhlet extraction with a hydroethanolic solvent to obtain flavonoid-rich extracts. The UV absorption spectra were recorded in the ultraviolet-B region (290–320 nm) at 5 nm intervals, and SPF values were calculated using the Mansur equation. Both extracts exhibited measurable absorbance across the erythemogenic UV-B range, indicating their ability to absorb biologically relevant ultraviolet radiation. At a concentration of

7.5 mg/ml, the purple variety showed a higher SPF value (37.44) compared to the yellow variety (30.93), both samples demonstrated a concentration-dependent increase in SPF. The superior photoprotective activity of the purple variety was attributed to a higher content or more favorable profile of UV-absorbing phytoconstituents, particularly flavonoids and polyphenols. These findings suggested that passion fruit leaves, commonly discarded as agro-

waste, possessed significant natural photoprotective potential and could serve as sustainable, plant-based ingredients for the development of eco-friendly sunscreen formulations.

KEYWORDS: Ultraviolet (UV) protection, *Passiflora edulis* leaf, Soxhlet extraction, Sun Protection Factor (SPF), UV spectrophotometry, Mansur equation.

INTRODUCTION

Excessive exposure to solar ultraviolet (UV) radiation was a key environmental factor responsible for various adverse skin effects, including erythema, premature ageing, immune suppression, and skin cancer. The UV radiation reaching the Earth's surface mainly consisted of UV-A (320-400 nm), UV-B (290-320 nm) rays and UV-C (200-290), among them UV-A and UV-B could penetrate the skin and induce cellular damage. UV-B radiation primarily caused sunburn and direct DNA injury, while UV-A penetrated deeper into the dermis, generated reactive oxygen species, and accelerated photoaging while compromising skin integrity. Consequently, effective photoprotection became essential in modern skincare and public health.



Fig 1: *Passiflora edulis*.Sims.



Fig 2: *Passiflora edulis* f. *flavicarpa* O.Deg.

Sunscreens reduced UV-induced damage by absorbing, reflecting, or scattering ultraviolet radiation. Their effectiveness was commonly expressed as the Sun Protection Factor (SPF), which reflected protection against UV-B-induced erythema. Although synthetic UV filters were widely used, concerns related to their safety, environmental impact, and long-term use increased interest in natural alternatives. In this context, plant-derived extracts rich in flavonoids and polyphenols gained attention due to their UV-absorbing and antioxidant properties.^{[11][2]}

Passiflora edulis (passion fruit), a member of the family Passifloraceae, was valued for its nutritional and medicinal uses. While the fruit was widely consumed, the leaves were often discarded despite being rich in bioactive compounds such as flavonoids and phenolic acids. Phytoconstituents including orientin, isoorientin, vitexin, and rutin present in the leaves were reported to exhibit antioxidant, anti-inflammatory, and photoprotective activities, suggesting their potential role in skin protection.^{[5][6]}

Therefore, the present study aimed to evaluate the in vitro sun protection factor of *Passiflora edulis* leaf extract using UV spectrophotometry. The study established its suitability as a natural sunscreen ingredient while supporting the sustainable utilization of plant by-products in eco-friendly skincare formulations.

MATERIALS

Equipment

- Hot air oven (SENTWIN INDIA)
- Motor and pestle
- Mechanical Sieve Mesh no: 44 (SENTWIN INDIA)
- Digital Balance (MARC)
- Heating mantle (SENTWIN INDIA)
- Soxhlet System (We Tech)
- UV-Spectrophotometer (SYSTRONICS, software-SYSTRONICS)

Reagents and chemicals

- Sample Material – Dried passion fruit leaves
- Defatting Solvent – Hexane (ISOCHEM Laboratories)
- Extraction Solvent – Ethanol. (ISOCHEM Laboratories)
- Shinoda Test – Magnesium Ribbon, Conc.HCl (ISOCHEM Laboratories)

Consumables

- Glassware – Beakers, Petridish, Funnel(BOROSIL)
- Filter Papers (11µm) (ARGON SCIENTIFIC)
- Protective Equipment – Lab coat, gloves.



Fig 3: Soxhlet Extraction System.

METHODOLOGY

1. Sample Preparation

Fresh leaves of *Passiflora edulis* (purple variety) and *Passiflora edulis* f. *flavicarpa* (yellow variety) were collected and washed thoroughly with distilled water to remove surface impurities. The midrib was removed, and the lamina was cut into small pieces. The leaves were dried in a hot air oven at 42 °C to avoid degradation of thermolabile constituents. The dried material was pulverized, passed through a 44-mesh sieve to obtain uniform powder, and stored in airtight containers protected from light until use.



Fig 4: Dried Passion fruit Leaf.



Fig 5: Passion fruit Leaf powder.

2. Defatting of Leaf Powder

An accurately weighed 2.45 g of leaf powder was placed in a Soxhlet thimble and defatted using 240 ml of n-hexane in a Soxhlet apparatus. The defatting process was carried out at 70°C for 4 hours, completing approximately 24 reflux cycles. After completion, the defatted

powder was removed and air-dried to eliminate residual solvent. This step was performed to remove lipids, waxes, and chlorophyll that might have interfered with UV spectrophotometric analysis.^[7]

3. Soxhlet Extraction

The defatted leaf powder was subjected to Soxhlet extraction using 70% (v/v) ethanol as the solvent. The extraction was carried out with 240 ml of solvent at 45 ± 5 °C for 8 hours, corresponding to approximately 28 reflux cycles. After extraction, the solvent was filtered and concentrated at 45 ± 5 °C until a semi-solid residue was obtained. The extract was weighed and stored in airtight containers for further analysis.^{[1][3]}

4. Preparation of stock solution and dilutions



Fig 6: Stock Solution.

A stock solution was prepared by dissolving 593 mg of the concentrated extract in 5.93 mL of 70% ethanol to obtain a concentration of 100 mg/mL. Further dilutions of 10 mg/mL, 7.5 mg/mL, and 5 mg/mL were prepared using the dilution equation ($C_1V_1 = C_2V_2$).



Fig 7: First Dilution (10mg/ml)



Fig 8: Half Dilution (5mg/ml)

5. Qualitative Test for Flavonoids

The presence of flavonoids was confirmed by the Shinoda test. To 2 mL of the extract, a small piece of magnesium ribbon was added, followed by 2–3 drops of concentrated hydrochloric acid. The development of an orange coloration indicated the presence of flavonoids.^[3]



Fig 9: Shinoda Test.

6. UV Spectrophotometric Analysis and SPF Determination

UV absorbance measurements were performed using a UV–Visible spectrophotometer after baseline correction with 70% ethanol as the blank. A full scan was recorded between 200 and 400 nm. For in vitro SPF determination, absorbance values were recorded in the UV-B region (290–320 nm) at 5 nm intervals, following the Mansur method. SPF values were calculated using the Mansur equation.^{[10][11]}



Fig 10: UV Spectrophotometer.

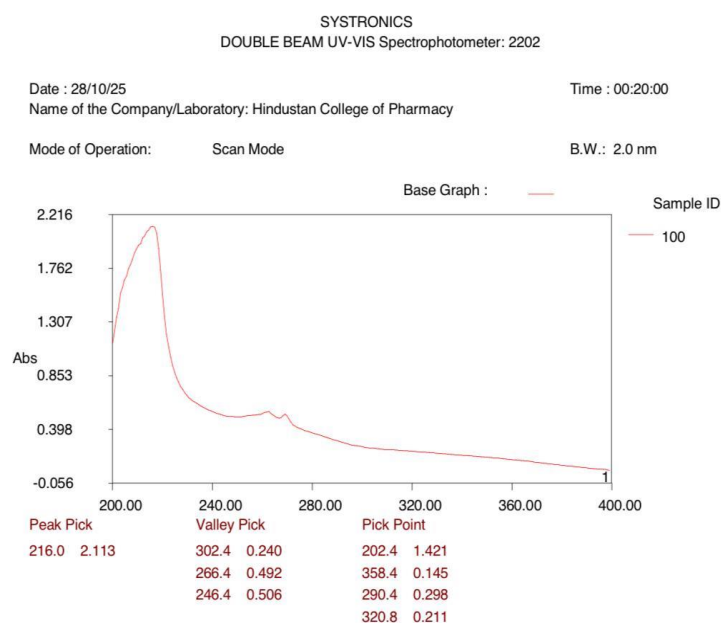
RESULTS

The SPF of passion fruit leaf extract was determined using UV spectrophotometric analysis based on the Mansur equation.

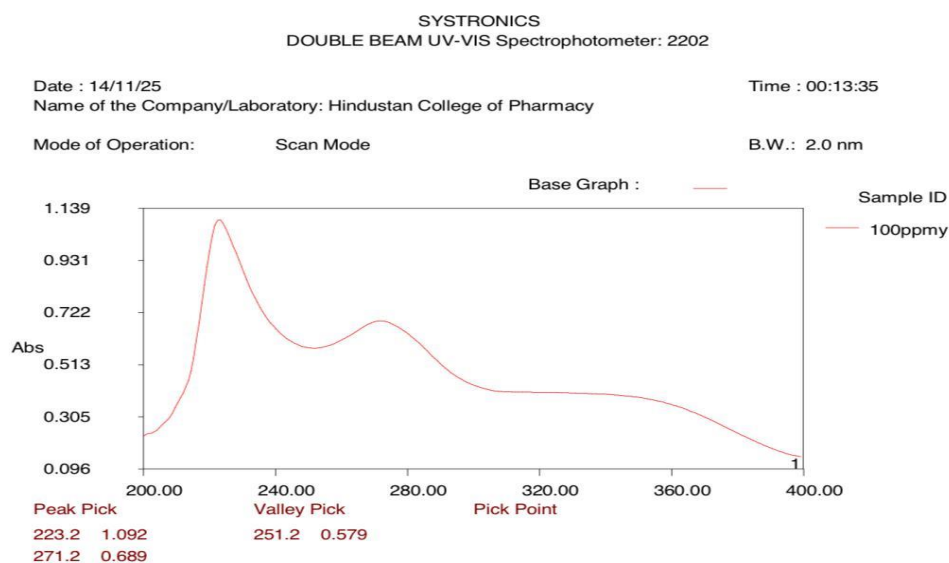
$$\text{SPF} = \text{CF} \times \sum \text{EE}(\lambda) \times \text{I}(\lambda) \times \text{Abs}(\lambda)$$

- $\text{EE}(\lambda)$ is the erythemal effect spectrum.
- $\text{I}(\lambda)$ is the solar intensity spectrum.
- $\text{Abs}(\lambda)$ is the absorbance of the sample at a given wavelength.
- CF is correction factor which is a constant 10.
- $\text{EE}(\lambda) \times \text{I}(\lambda)$ has constant values at different wavelength.^[11]

The SPF of passion fruit leaf (*P.edulis*) extract was determined by using UV spectrophotometric analysis



The SPF of passion fruit leaf (*P.flavicarpa*) extract was determined by using UV spectrophotometric analysis



Multi wavelength analysis of passion fruit leaf extract (*P. edulis* and *P.flavicarpa*) at 7.5 mg/ml and 5 mg/ml

SYSTRONICS
DOUBLE BEAM UV-VIS Spectrophotometer: 2202

Date : 12/01/26
Name of the Company/Laboratory: Hindustan College of Pharmacy
Sample ID:
Mode of Operation: Multi Wavelength Mode
Time : 10:42:08
B.W.: 2.0 nm

Multi Wavelength Analysis			Absorbance mode
WL-nm	01	02	
	Cell 01	Cell 01	
	purple	yellow	
290.0	4.000	4.000	
295.0	4.000	4.000	
300.0	4.000	3.468	
305.0	3.237	2.760	
310.0	3.972	2.768	
315.0	4.000	2.831	
320.0	4.000	2.935	

SYSTRONICS
DOUBLE BEAM UV-VIS Spectrophotometer: 2202

Date : 03/12/25
Name of the Company/Laboratory: Hindustan College of Pharmacy
Sample ID:
Mode of Operation: Multi Wavelength Mode
Time : 15:43:30
B.W.: 2.0 nm

Multi Wavelength Analysis			Absorbance mode
WL-nm	01	02	
	Cell 01	Cell 01	
	p 5mg	y 5mg	
290.0	2.323	2.323	
295.0	2.247	2.178	
300.0	2.216	2.066	
305.0	2.195	2.013	
310.0	2.218	2.001	
315.0	2.249	2.019	
320.0	2.273	2.027	

Table 1: The SPF of passion fruit leaf (*P.edulis*) extract was determined by using UV spectrometric analysis.

Wavelength	EE*I ⁽⁵³⁾	Absorbance of extract at 5 mg/ml	Absorbance of extract at 7.5 mg/ml
290 nm	0.0150	2.323	4.000
295 nm	0.0817	2.247	4.000
300nm	0.2874	2.216	4.000
305 nm	0.3278	2.195	3.237
310 nm	0.1864	2.218	3.972

315 nm	0.0837	2.249	4.000
320nm	0.0180	2.273	4.000
SPF VALUES		22.17	37.44

Table 2: The SPF of passion fruit leaf (*P. flavicarpa*) extract was determined by using UV spectrometric analysis.

Wavelength	EE*I ⁽⁵³⁾	Absorbance of extract at 5 mg/ml	Absorbance of extract at 7.5 mg/ml
290 nm	0.0150	2.323	4.000
295 nm	0.0817	2.178	4.000
300nm	0.2874	2.066	3.468
305 nm	0.3278	2.013	2.760
310 nm	0.1864	2.001	2.768
315 nm	0.0837	2.019	2.831
320nm	0.0180	2.027	2.935
SPF VALUES		20.45	30.93

The results revealed a concentration-dependent increase in SPF for both extracts. At a concentration of 5 mg/mL, the ethanolic leaf extract of *P. edulis* showed an SPF value of 22.17, which increased to 37.44 at 7.5 mg/mL. Similarly, *P. flavicarpa* exhibited SPF values of 20.45 and 30.93 at concentrations of 5 mg/mL and 7.5 mg/mL, respectively. These values indicated effective absorption of UV-B radiation by both extracts. The higher SPF value indicated higher flavonoid and phenolic content.

DISCUSSION

The present study demonstrated that ethanolic leaf extracts of *Passiflora edulis* Sims and *Passiflora edulis* f. *flavicarpa* O. Deg possessed significant in vitro sun protection activity, as evidenced by their UV absorption in the UV-B region (290–320 nm). This region was primarily responsible for erythema and sunburn, making SPF evaluation within this range biologically relevant.

UV spectrophotometric analysis revealed that the purple variety exhibited stronger and more consistent absorbance across the UV-B region compared to the yellow variety. Both extracts showed characteristic absorption peaks in the ultraviolet range, indicating the presence of UV-active phytoconstituents. These findings were in agreement with earlier reports which stated that flavonoids and polyphenols, owing to their conjugated structures, effectively absorbed ultraviolet radiation and contributed to photoprotection.^[9]

The SPF values calculated using the Mansur method showed a concentration-dependent increase for both extracts. *P. edulis* exhibited higher SPF values (22.17 and 37.44 at 5 and 7.5 mg/mL, respectively) than *P. flavicarpa* (20.45 and 30.93), suggesting superior photoprotective potential of the purple variety. This difference might have been attributed to variations in flavonoid composition and concentration, as previous studies had reported higher levels of orientin, isoorientin, vitexin, and related polyphenols in *P. edulis* leaves. In addition to UV absorption, these compounds were known to provide antioxidant protection by scavenging UV-induced reactive oxygen species.

The defatting step prior to extraction likely enhanced SPF accuracy by removing chlorophyll and other non-polar constituents that could interfere with UV absorbance measurements. The use of 70% ethanol further improved extraction efficiency of polar, UV-active compounds while minimizing thermal degradation.

When compared with other reported plant-based sunscreen agents, passion fruit leaf extracts showed comparatively high SPF values at lower concentrations. Although slightly lower than standard *Citrus aurantifolia* extract, the results highlighted the potential of passion fruit leaves, which were often discarded as agricultural waste, as a sustainable and eco-friendly source of natural photoprotective agents.^[4] Further formulation and in vivo studies were warranted to confirm their suitability for topical application.

CONCLUSION

The present investigation demonstrated that ethanolic leaf extracts of *Passiflora edulis* and *Passiflora edulis* f. *flavicarpa* possessed notable in vitro sun protection activity. Both extracts effectively absorbed UV-B radiation, with the purple variety exhibiting superior SPF values compared to the yellow variety. The observed photoprotective activity was likely associated with the presence of flavonoids and polyphenolic compounds known for their UV-absorbing and antioxidant properties.

These findings highlighted passion fruit leaves, a commonly discarded agricultural by-product, as a promising and sustainable source of natural sunscreen agents. The study supported their potential use as plant-based alternatives or adjuncts to synthetic UV filters. However, further studies involving formulation development, photostability testing, and in vivo SPF evaluation were necessary to confirm their efficacy and safety for topical application.

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ANNEXURE



05/02/2026
Palai

Certificate

This is to certify that the plant specimen submitted to me by Ajisha Shibu, Asil Samad, Devika A. S., Falaha Kabeer, and Haifa Shajahan of Hindusthan College of Pharmacy, Chenappady P.O., Kanjirappally, has been identified as follows.

Scientific Name of the Plants: *Passiflora edulis* Sims (Purple colored fruit)

Passiflora edulis f. flavicarpa O. Deg. (Yellow colored fruit)

Family: Passifloraceae

Local Name: Passion fruit

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