

# ***In-vitro* evaluation of sun protection factor of various solvent extracts from *Phragmites Australis***

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## **ABSTRACT**

Overexposure to ultraviolet rays is a key environmental trigger for dermal injury, premature aging, and skin cancer development. Conventional sunscreens, formulated with synthetic chemical agents, are effective in absorbing or reflecting UV rays; however, their prolonged use has been implicated with side effects such as skin irritation, hypersensitivity, and photoallergic reactions. This has prompted growing interest in natural alternatives, particularly plant-derived compounds, which offer photo-protective benefits along with additional antioxidant activity. Plants are rich sources of bioactive compounds such as phenols, flavonoids, and tannins, which are considered to scavenge free radicals and absorb UV radiation, thereby reducing reactive oxygen species and phototoxic damage. The exploration of botanical extracts as sunscreen ingredients not only addresses safety concerns but also aligns with the increasing demand for eco-friendly and biocompatible formulations. *Phragmites australis* (common reed), a perennial grass widely distributed across wetlands, has been traditionally recognized for its diverse pharmacological properties. Despite its abundance, limited studies have investigated its capability as a photo-protective compound. In this study, the whole plant of *Phragmites australis* was extracted using water, chloroform, and ethanol through cold maceration. Preliminary phytochemical screening confirmed the presence of phenols, tannins, and flavonoids in every extract. The sun protection factor (SPF) was assessed via the UV spectroscopic analysis, yielding values of  $1.5338 \pm 0.016$  for the aqueous extract,  $2.2699 \pm 0.003$  for the chloroform extract, and  $11.025 \pm 0.022$  for the ethanolic extract. These findings highlight the potential of *Phragmites australis* extracts, particularly the ethanolic fraction, as natural sunscreen agents. Furthermore, combining extracts in optimized ratios may enhance photo-protective efficacy through synergistic or additive effects, supporting their application in the development of safe, plant-based topical formulations.

**Keywords:** *Phragmites australis*, Sun protection factor, UV radiation, Mansur equation.

## **INTRODUCTION**

The skin protects against outside threats, but can be damaged by excessive exposure<sup>1</sup>. Factors such as radiation, heavy metals, and pathogens affect the skin's protective system. In tropical countries like Indonesia, exposure to sunlight is constant, with temperatures reaching up to 50°C during summer. This heat can cause dehydration, dryness, and increased vulnerability to sunburn<sup>2</sup>.

UV radiation, a component of sunlight, excites electrons in skin molecules from their lower energy state to a higher energy state, damaging skin defenses and leading to tissue abnormalities. Sun exposure can cause burns, skin cancer, oxidative damage, erythema, inflammation, hyperpigmentation, wrinkle formation, and immunosuppression<sup>3</sup>. Solar UV radiation is categorized as UV-C (200–290 nm), UV-B (290–320 nm), and UV-A (320–400 nm) [8]. While UV-C is filtered by the atmosphere, UV-B penetrates

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the ozone layer and causes sunburn. UV-A reaches deeper epidermal and dermal layers, accelerating skin aging<sup>4</sup>. Several sunscreen formulations exist, including creams, gels, oils, lotions, moisturizers, ointments, and waxes. Although synthetic sunscreens provide broad protection and act quickly, they are often expensive and may cause adverse effects<sup>5</sup>.

Recently, natural compounds from plants have been studied as sunscreen agents due to their UV absorption and antioxidant activities. Herbal sunscreens are affordable, accessible, and generally safer<sup>6</sup>. Antioxidants like vitamins, flavonoids, polyphenols, and carotenoids protect skin against UV damage. Key bioactive compounds include vitamins C and E, quercetin, lycopene, beta-carotene, resveratrol, and phenolic compounds<sup>7</sup>. Physical blockers like titanium dioxide and zinc oxide are also widely used. The skin's natural sun protection includes lipids, proteins, and nucleotides<sup>8</sup>. Research on herbal ingredients continues to expand due to their reduced skin irritation and fewer harmful effects compared to synthetic sunscreens. Sunscreen efficacy is typically expressed by the sun protection factor (SPF)<sup>9</sup>. SPF is defined as the ratio of UV energy required to produce minimal erythema dose (MED) on protected skin versus unprotected skin. Human volunteer phototesting measures sunscreen protection levels<sup>10</sup>. Sunscreens protect against sunburn and shield the skin from harmful UV-A and UV-B radiation, but natural active substances are preferred in skincare due to skin sensitivity, eco-friendliness, and fewer side effects. Natural substances also offer benefits like antioxidant, wound healing, antimicrobial, antibacterial, and dental therapeutic properties<sup>11</sup>. Synthetic chemicals can cause skin discomfort and other health risks. Antioxidant capacity plays a significant role in sunscreen photoprotection<sup>12, 13</sup>. Previous studies show *Amaranthus viridis* and *Solanum nigrum* contain high levels of flavonoids, particularly quercetin and rutin, exhibiting effective UV radiation blocking. Methanolic extracts were more potent than aqueous ones. Compared to *Solanum nigrum*, *Amaranthus viridis* extracts have higher flavonoid and phenolic content and greater UV protection<sup>14</sup>.

Extracts from *Polyalthia longifolia* have demonstrated sun-protective properties. SPF values of

bark extracts in ethanol, water, and chloroform were measured using UV spectrophotometry. Due to their flavonoid content, these extracts are widely used in skin cosmetics and suggested for enhancing SPF in sunscreen formulations<sup>15</sup>.

*Phragmites australis* is a rhizomatous perennial reaching up to 6 m tall in aquatic or damp habitats. Its inflorescence ranges from green to purple-brown, and it is rich in flavonoid glycosides characteristic of the Poaceae family<sup>16</sup>. It contains bioactive compounds such as benzoic acid, alpha-D-glucose, Aurantiamide acetate, beta-sitosterol, methyl gallate, palmitic acid, benzoic acid, p-coumaric acid, stigmasterol, vanillic acid, syringic acid, and lyoniresinol derivatives<sup>17</sup>. *Phragmites australis* possesses pharmacological activities including anticancer, hepatic and renal protection, antibacterial, antiviral, anti-inflammatory, and skin protection. This study investigates the phytochemical profile and sun-protective effects of *Phragmites australis* extracts obtained by cold maceration with water, chloroform, and ethanol<sup>17</sup>. *Phragmites australis* was selected for this study due to its abundant phytochemical constituents and ethnomedicinal relevance. The plant is a natural source of flavonoids, phenolic acids, and tannins—compounds known for their antioxidant activity and UV-absorbing capacity. Its traditional use in treating skin-related ailments supports its potential for dermatological applications. As a fast-growing and widely distributed wetland species, *P. australis* offers ecological sustainability and cost-effective extractability. The use of multiple solvents enables targeted isolation of bioactive compounds, allowing comparative evaluation of photoprotective efficacy. Despite its pharmacological promise, its UV-protective properties remain underexplored, making this investigation both timely and novel. The study aims to statistically validate extract performance and contribute meaningful insights to the development of plant-based photoprotective agents.

Binomial name - *Phragmites australis*

Kingdom - Plantae

Order - Cyperales

Genus - Phragmites



|        |                   |
|--------|-------------------|
| Family | - Poaceae         |
| Class  | - Monocotyledonae |
| Phylum | - Spermatophyta   |

## MATERIAL AND METHODS:

### Material

Whole plants of *Phragmites australis* were gathered from Khatauli, Gangnahar in Uttar Pradesh. The botanical samples were authenticated by the Botanical Survey of India (BSI) located in Noida, U.P. (Reference No.-BSI/BGIR/1/TECH./2024/98). The collected plants were dried in the shade, then separated and ground using a mechanical grinder. The powdered material was sieved through a 40-mesh screen. Chemicals such as ethanol and chloroform used for pharmacognostical analysis were sourced from Kumar Chemicals, Soot Ki Mandi, Kasganj-207123 (U.P.).

### Extraction of *Phragmites australis*

The collected plant material was washed thoroughly with running water and fragmented into smaller parts using a cutter. The pieces were air-dried for 8 days<sup>18</sup>. Using the cold maceration method, 100 g of *Phragmites australis* powder was extracted separately with 1000 ml of different solvents (water, chloroform, and ethanol) over 72 hours<sup>19</sup>. After filtration and concentration in a water bath, the extracts were dried. The resulting extracts were dark in color and stored in airtight containers, which were refrigerated at 4°C<sup>20</sup>.

### Preliminary Phytochemical Screening

Standard qualitative procedures were conducted to identify the detection of carbohydrates, tannins, glycosides, flavonoids, alkaloids, phenols, and saponins following established protocols<sup>21</sup>.

### In Vitro Evaluation of SPF Using the Mansur Equation

The sun protection factor of each extract was determined by Mansur's spectrophotometric technique. Approximately 0.2 g of each extract (water, chloroform, and ethanol) was weighed, transferred to a 100 ml volumetric flask, diluted to volume with ethanol, and filtered. The initial 10 ml of filtrate was discarded<sup>22, 23</sup>. From the remaining solution, a 25 ml aliquot was taken and further diluted to 50 ml with ethanol. Before UV spectrophotometric measurement, ethanol was used to adjust the final concentration of the sample. Absorbance readings were taken three times at wavelengths within 290 and 320 nm (UV-B region) at 5 nm divisions<sup>24</sup>.

$$320$$

$$SPF_{spectrophotometric} = CF \times \sum_{290}^{320} EE(\lambda) \times I(\lambda) \times Abs(\lambda)$$

$$290$$

Where CF is the correction factor (10),  $EE(\lambda)$  is the erythrogenic effect of radiation with wavelength  $\lambda$ , and  $Abs(\lambda)$  is the spectrophotometric absorbance values at wavelength  $\lambda$ . The values of  $EE \times I$  are constants<sup>25, 26</sup>.

### Statistical Analysis

All assays were carried out in triplicate, with results expressed as the mean  $\pm$  SD to ensure reliability and reproducibility.

## RESULTS:

### Preliminary Phytochemical Screening

The preliminary screening detects the presence of terpenoids, steroids, fatty acids, glycosides, flavonoids, carbohydrates, and phenolic compounds in *Phragmites australis* extracts. These secondary metabolites are well-known contributors to the medicinal properties of plants. Specifically, all extracts contained tannins, flavonoids, and phenols, compounds recognized for their free radical scavenging ability (Table 1).

**Table 1. Preliminary phytochemical screening of *Phragmites australis* extracts**

| Chemical Constituents | Aqueous Extract | Chloroform Extract | Ethanol Extract |
|-----------------------|-----------------|--------------------|-----------------|
| Alkaloids             | +               | -                  | +               |
| Glycosides            | +               | -                  | -               |



|                                |   |   |   |
|--------------------------------|---|---|---|
| Flavanoids                     | + | + | + |
| Carbohydrates                  | + | - | + |
| Saponins                       | + | + | + |
| Phenolic Compounds and Tannins | + | + | + |
| Test for protein               | + | + | + |
| Test for oils & fats           | - | - | - |
| Test for amino acid            | - | - | - |
| Test for resin                 | - | - | - |

Present (+), Negative(-).

### Sun Protection Factor of *Phragmites australis* Extracts

The SPF rating of *Phragmites australis* extracts was measured using an in vitro spectrophotometric method. The absorbance characteristics of the sample solutions were analyzed according to the Mansur equation. The absorption profiles, which illustrate the distinct UV-B absorption properties of the extracts,

are presented in Figures 1 to 3. UV-B radiation was selected for SPF evaluation in this study due to its higher incidence during daylight hours and its longer exposure duration for individuals. The SPF values obtained for the various extracts are summarized in Table 2 and Figure 4. Specifically, the water extract showed an SPF of  $1.5338 \pm 0.016$ , the chloroform extract had an SPF of  $2.2699 \pm 0.003$ , and the ethanol extract exhibited the highest SPF at  $11.025 \pm 0.022$ .

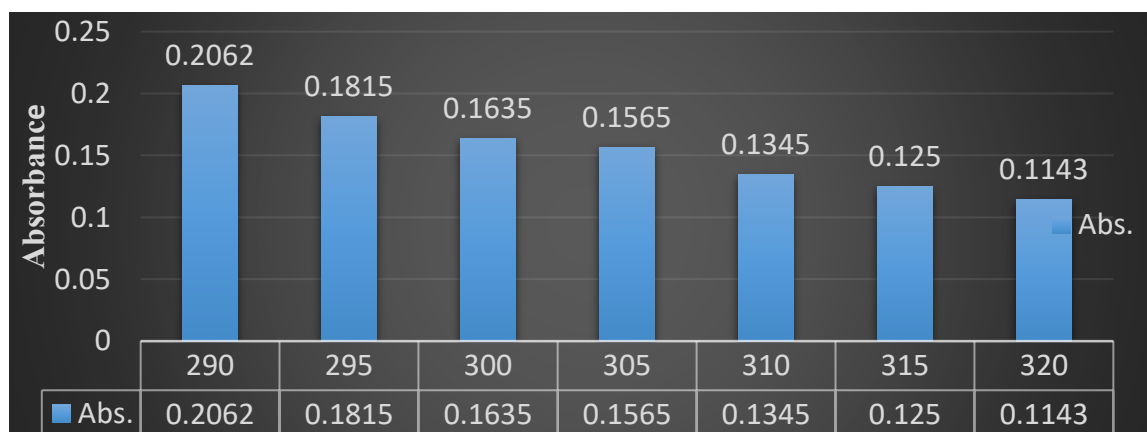


Figure 1. Absorption profile of aqueous extract of *Phragmites australis*.

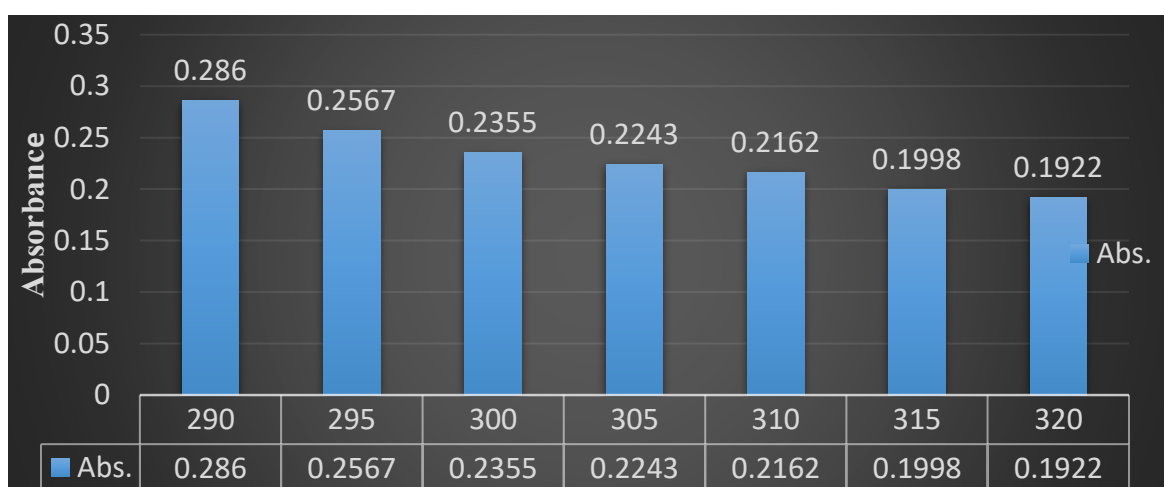


Figure 2. Absorption profile of chloroform extract of *Phragmites australis*



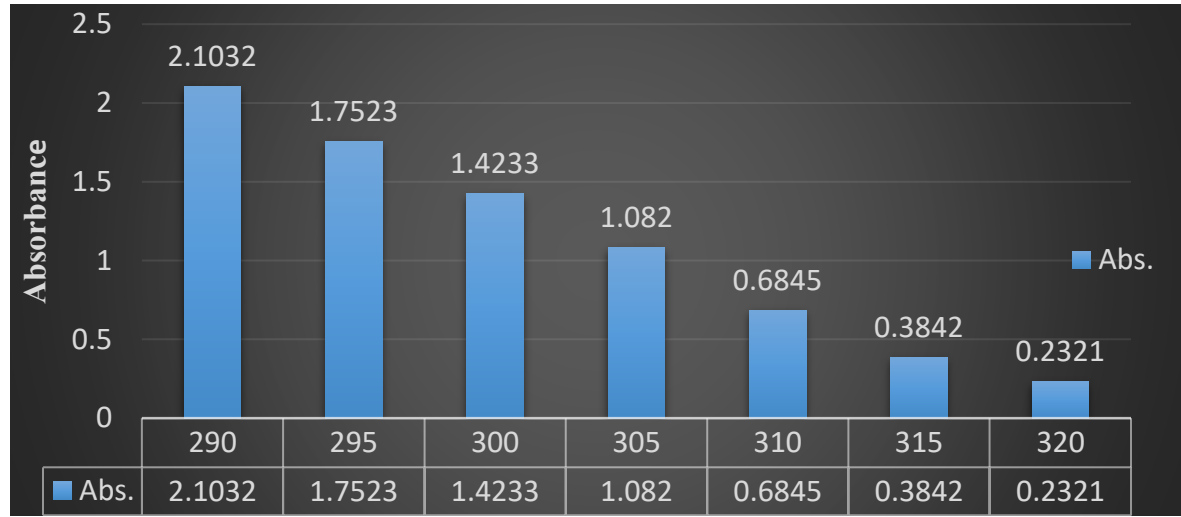


Figure3.Absorption profile of ethanol extract of *Phragmites australis*.

Table 2. Sun protection factor values of all extracts of the *Phragmites australis* plant

| Type of extract | Sun protection factor |
|-----------------|-----------------------|
| Aqueous         | 1.5338±0.016          |
| Chloroform      | 2.2699 ±0.003         |
| Ethanolic       | 11.025±0.022          |

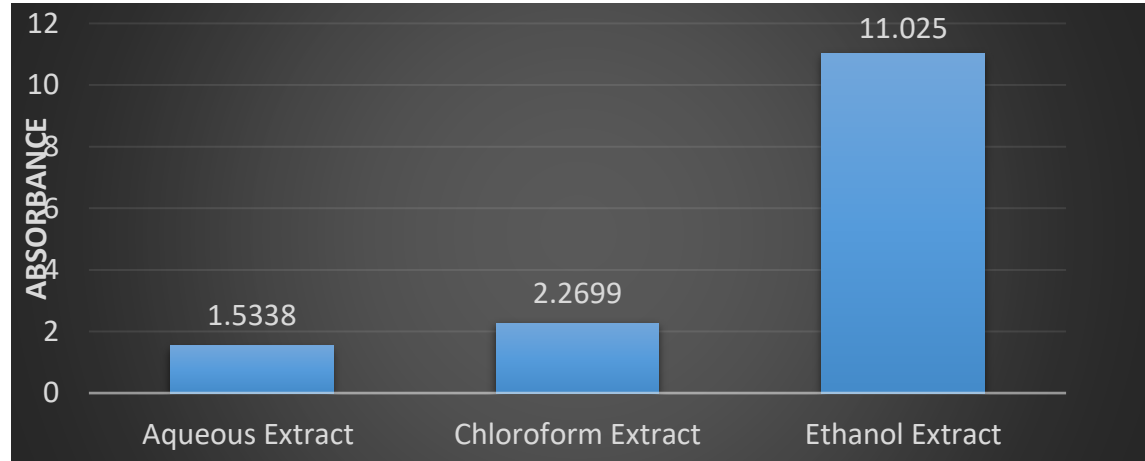


Figure 4: Comparative sun protection factor values of aqueous, chloroform, and ethanol *Phragmites australis* extracts. UV absorbance was measured between 290 and 320 nm with a 5 nm interval according to the Mansur equation.

DISCUSSION

The present investigation explored the phytochemical composition of *Phragmites australis* and assessed its potential to absorb UV-B radiation. Preliminary qualitative screening revealed the presence of diverse bioactive metabolites, including flavonoids, tannins, terpenoids, steroids, glycosides, saponins, phenolic acids, and carbohydrates, across extracts obtained with solvents of varying polarity. These compounds

are well recognized for their free radical scavenger and anti-solar activity, suggesting a synergistic role in mitigating UV-induced damage. In vitro determination of the sun protection factor (SPF) using Mansur’s spectrophotometric protocol demonstrated a progressive enhancement in photoprotective efficacy, with values increasing from the aqueous extract to the chloroform fraction and reaching the highest level in the ethanolic extract. This gradient underscores the critical role of solvent polarity in

selectively extracting UV-active phytochemicals, with ethanol proving most effective in concentrating phenolic and flavonoid constituents responsible for strong UV absorption. *P. australis* is a promising source of natural photoprotective agents, but also provides a scientific basis for its potential incorporation into herbal sunscreen formulations. By linking phytochemical richness with measurable SPF activity, the study establishes a foundation for further formulation research, quantitative phytochemical analysis, and in vivo validation to advance the development of safe, plant-based alternatives to synthetic sunscreens.

## CONCLUSION

This study highlights the potential of *Phragmites australis* as a valuable source of natural photoprotective agents. The sun protection factor of its aqueous, chloroform, and ethanolic extracts, determined through UV spectrophotometric analysis, demonstrated that the plant possesses measurable sun-blocking capacity. The relatively high SPF observed in the ethanol fraction can be attributed to its enriched flavonoid and phenolic content, compounds well known for their antioxidant and UV-absorbing properties. These findings suggest that *P. australis* extracts could serve as effective bioactive ingredients in the formulation and optimization of skincare and cosmetic products. Furthermore, their incorporation into conventional sunscreen products may enhance SPF values while reducing reliance on synthetic UV filters, thereby offering a safer and more sustainable alternative for photoprotection.

**Conflict of Interest** The authors declare no conflict of interest.

**Authors' Declaration** The authors hereby declare that the work presented in this article is original and that any liability for claims relating to the content of this article will be borne by them.

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