CODEN [USA]: IAJPBB ISSN : 2349-7750

INDO AMERICAN JOURNAL OF
PHARMACEUTICAL SCIENCES
SJIF Impact Factor: 7.187

Available online at: http://www.iajps.com Research Article

PHYTOCHEMICAL SCREENING AND ESTIMATION OF SPF NUMBER ON HERBAL EXTRACTS BY USING UV SPECTROSCOPY

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Abstract:

This study investigates the phytochemical composition, yield, and UV absorbance properties of ethanolic extracts from Actinidia deliciosa, Daucus carota, Vitis vinifera, Beta vulgaris, Carica papaya, and Solanum lycopersicum. The extracts showed varying yields, with Actinidia deliciosa having the highest. Phytochemical screening revealed alkaloids, carbohydrates, glycosides, tannins, and phytosterols in all extracts, with flavonoids and saponins present in Beta vulgaris, Carica papaya, and Solanum lycopersicum. UV absorbance analysis indicated Actinidia deliciosa and Daucus carota had the highest UV protection potential. The study suggests these plants could be promising candidates for natural sunscreen formulations.

Keywords: Phytochemicals, UV Protection, Ethanolic Extracts, Natural Sunscreens, Antioxidants

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Please cite this article in press M.Ramesh Babu et al., ***Phytochemical Screening And Estimation Of SPF Number On Herbal Extracts By Using Uv Spectroscopy .,****Indo Am. J. P. Sci, 2025; 12 (03)*

INTRODUCTION:

With the growing demand for natural and sustainable alternatives in skincare, herbal extracts have gained significant attention for their potential use in sunscreens. These natural products offer a wide array of bioactive compounds, including antioxidants, flavonoids, and carotenoids, which may help protect the skin from harmful ultraviolet (UV) radiation. UV radiation, especially UVB rays, can lead to premature skin aging, pigmentation, and increase the risk of skin cancer. As a result, sunscreens with high Sun Protection Factor (SPF) are essential for protecting the skin from these harmful effects.

In recent years, herbal extracts have shown promise as natural UV protectants. The bioactive compounds in plants have demonstrated various medicinal properties, including antioxidant, anti-inflammatory, and antimicrobial activities, which can contribute to photoprotection. Plant extracts such as **Actinidia deliciosa**, **Daucus carota**, **Vitis vinifera**, **Beta vulgaris**, **Carica papaya**, and **Solanum lycopersicum** have been widely studied for their medicinal value and potential as natural sunblock agents.

UV spectroscopy, a widely recognized analytical technique, can be employed to assess the UV absorbance properties of these herbal extracts. By measuring the absorbance in the UV-B region (290-320 nm), it is possible to estimate the extract's SPF and evaluate its protective potential. The phytochemical content of these plants, such as flavonoids, carotenoids, and polyphenols, plays a key role in their ability to absorb UV radiation, thus offering protection against skin damage.

This study aims to investigate the phytochemical composition and UV absorbance properties of the ethanolic extracts of the selected plants to assess their suitability as natural sunscreen agents. The results could open new avenues for developing safer, plant-based sunscreen formulations with enhanced UV protection.

MATERIALS and METHODS:

Materials Required

Chemicals Required

- Ethanol
- Water

Instruments Required

- Double Beam UV-Spectrophotometer
- Heating Mantles

Collection and Authentication of Plant Material

The plant materials **Actinidia deliciosa** (Kiwi), **Daucus carota** (Carrot), and **Vitis vinifera** (Grapes) , Beta vulgaris , Carica papaya , Solanum lycopersicum were collected in February 2025 from the local market. The collected plant materials were authenticated based on their botanical characteristics.

Preparation of Ethanolic Extract

Method: The ethanolic extract of the plant material was prepared using the reflux condensation process. About **200 g** of fresh fruits was weighed and placed in a **500 mL round bottom flask** with **200 mL of ethanol**. The mixture was refluxed for **8 hours at 40°C**. The suspension was then filtered using a fine muslin cloth. The solvent was evaporated by heating until the volume was reduced by **three-fourths**. The remaining solvent was allowed to evaporate at room temperature, yielding a **semi-solid residue** for further analysis.

Phytochemical Screening

Phytochemical Test	Method	Observation	Inference
Test for Glycosides			
Legal's Test	The extract was treated with **1 mL of Pyridine** and **Sodium Nitroprusside**, then made alkaline with **NaOH**.	Pink to red color appears.	Glycosides are present.
Borntrager's Test	The extract was treated with **Chloroform**, and the chloroform layer was separated. Then, **dilute Ammonia** was added.	Ammonia layer acquires pink color.	Glycosides are present.
Test for Saponins			
Froth Test	**2 mL of extract** was shaken with **water** in a test tube.	Stable froth (foam) is formed.	Saponins are present.
Test for Alkaloids			
Dragendorff's Test	Drug extract was treated with **Potassium Bismuth Iodide solution**.	Reddish-brown precipitate appears.	Alkaloids are present.
Mayer's Test	Drug extract was treated with **Potassium Mercuric Iodide solution**.	Cream-colored precipitate appears.	Alkaloids are present.
Test for Tannins	The extract was treated with **Chromic acid**.	No precipitate was found.	Tannins are present.
Test for Flavonoids			
Shinoda Test	The extract was treated with **Magnesium turnings** and **conc. HCl** dropwise.	Pink scarlet, crimson red, or green to blue color appears.	Flavonoids are present.
Zinc Hydrochloride Test	The extract was treated with **Zn dust and conc. HCl**.	Red color appears.	Flavonoids are present.
Test for Mucilage	The extract was treated with **Ruthenium red solution**.	Pink color appears.	Mucilage is present.
Test for Carbohydrates			
Molisch Test	The extract was treated with **alcoholic α-naphthol** and **conc. H_2SO_4** added through the sides of the test tube.	Violet color ring appears at the junction.	Carbohydrates are present.
Test for Proteins			
Xanthoproteic Test	**5 mL of extract** was treated with **conc. Nitric acid** and boiled. After cooling, **40% NaOH solution** was added.	Yellow precipitate turns orange.	Proteins are present.
Test for Phytosterols			
Salkowski Test	The extract was treated with **conc. H_2SO_4**.	Red color at the lower layer indicates sterols, yellow color indicates phytosterols.	Phytosterols are present.

SAMPLE PREPARATION

Weighing and Dilution:

- **1.0 g** of each sample was accurately weighed and transferred into a **100 mL volumetric flask**.
- The volume was made up with **ethanol** and subjected to **ultrasonication for 5 minutes**.
- The solution was then **filtered through cotton**, discarding the first **10 mL** of the filtrate.

2. **Sequential Dilutions**:
   - A **5.0 mL aliquot** of the filtrate was transferred into a **50 mL volumetric flask** and diluted to volume with ethanol.
   - From this, another **5.0 mL aliquot** was taken and transferred into a **25 mL volumetric flask**, followed by dilution to volume with ethanol.
3. **Spectrophotometric Analysis**:
   - Absorption data were recorded in the **290–320 nm** range at **5 nm intervals**.
   - Each measurement was performed **three times** for accuracy.
4. **SPF (Sun Protection Factor) Calculation**:
   - The **Mansur equation** was applied to determine SPF values.
   - SPF is mathematically calculated using:

$$SPF = \int_{\lambda} E(\lambda) \times I(\lambda) \times MPF(\lambda)\, d\lambda$$

- Where:
  - **E(λ)** = Solar irradiance spectrum
  - **I(λ)** = Erythemal action spectrum
  - **MPF(λ)** = Monochromatic protection factor (approximately the inverse of transmittance at a given wavelength)
  - **λ** = Wavelength

RESULTS AND DISCUSSION:

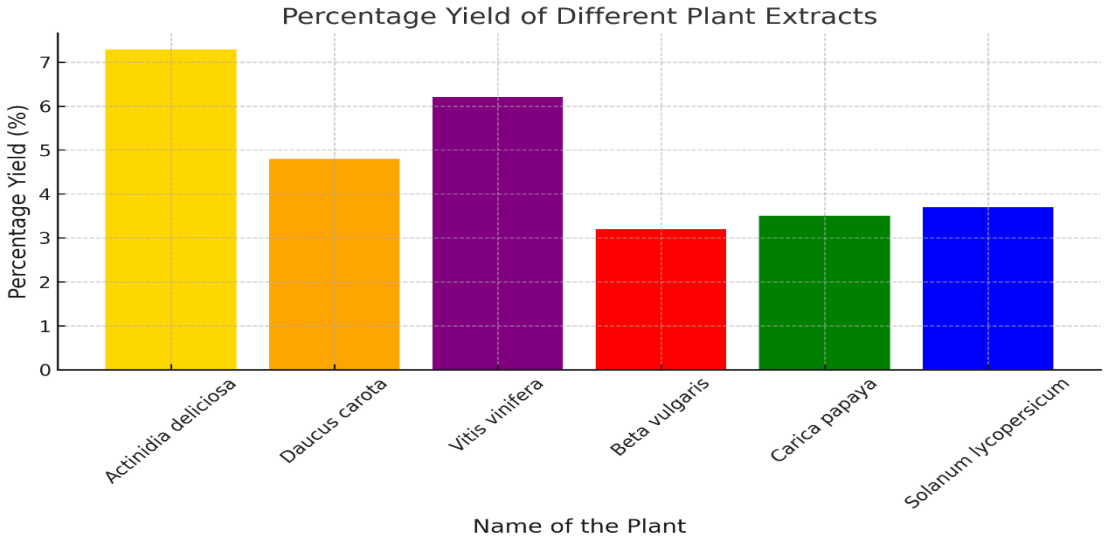
Percentage Yield of the Ethanolic Extract

The percentage yield of the ethanolic extract was determined for each plant sample. The yield varies depending on the plant species, its phytochemical composition, and the efficiency of the extraction process. The results are presented in **Table 3** below.

Percentage Yield of Ethanolic Extracts

Table –3 Percentage Yield of Ethanolic Extracts

S.No	Name of the Plant	Percentage Yield (%)
1	*Actinidia deliciosa*	7.29%
2	*Daucus carota*	4.8%
3	*Vitis vinifera*	6.2%
4	*Beta vulgaris*	3.2%
5	*Carica papaya*	3.5%
6	*Solanum lycopersicum*	3.7%



Discussion

The percentage yield of the extracts ranged from **3.2% (Beta vulgaris) to 7.29% (Actinidia deliciosa)**. The variation in yield may be attributed to differences in plant moisture content, solvent affinity, and the presence of specific phytochemicals.

- *Actinidia deliciosa* showed the highest yield (**7.29%**), likely due to its rich polyphenol and flavonoid content.
- *Daucus carota* and *Vitis vinifera* also yielded relatively higher extracts (**4.8% and 6.2%**, respectively), which may be due to their high carotenoid and tannin content.
- The lower yield observed in *Beta vulgaris* (**3.2%**) and *Carica papaya* (**3.5%**) suggests a lower solubility of their bioactive compounds in ethanol.
- *Solanum lycopersicum* had a moderate yield (**3.7%**), which could be attributed to the presence of lycopene and other lipid-soluble phytochemicals.

These results indicate that the efficiency of extraction varies across different plants, and optimization of extraction parameters may be necessary to improve the yield. The phytochemical constituents present in these extracts will be further analyzed for their potential role in sunscreen formulations.

Phytochemical Screening

The phytochemical analysis of the ethanolic extracts of the selected plants was conducted to identify the presence of various bioactive compounds, including alkaloids (Alk), carbohydrates (Carb), glycosides (Gly), tannins (Tan), phytosterols (Phytos), flavonoids (Flav), saponins (Sapo), proteins (Pro), and mucilage (Muci). The results are summarized in **Table 4** below:

Table 4: Phytochemical Screening of Ethanolic Extracts

Name of the Plant	Alk	Carb	Gly	Tan	Phytos	Flav	Sapo	Pro	Muci
Actinidia deliciosa	+	+	+	+	+	--	--	--	--
Daucus carota	+	+	+	+	+	--	--	--	--
Vitis vinifera	+	+	+	+	+	--	--	+	--
Beta vulgaris	+	+	+	+	+	+	+	+	-
Carica papaya	+	+	+	+	+	+	+	+	-
Solanum lycopersicum	+	+	+	+	+	+	+	+	-

Discussion

The results of the phytochemical screening indicate that all six plants contain **alkaloids, carbohydrates, glycosides, tannins, and phytosterols**, which are known for their various pharmacological activities.

- **Flavonoids** were absent in *Actinidia deliciosa*, *Daucus carota*, and *Vitis vinifera* but were present in *Beta vulgaris, Carica papaya,* and *Solanum lycopersicum*.
- **Saponins** were detected in *Beta vulgaris, Carica papaya,* and *Solanum lycopersicum*, which suggests their potential role in enhancing solubility and absorption.
- **Proteins** were only detected in *Vitis vinifera, Beta vulgaris, Carica papaya,* and *Solanum lycopersicum*.
- **Mucilage** was absent in all plant extracts, indicating a lack of significant polysaccharide-based gel-forming components.

These findings highlight the presence of bioactive compounds that could contribute to **UV protection, antioxidant properties, and skin health**, making these extracts promising candidates for sunscreen formulations.

Absorbance of Standard

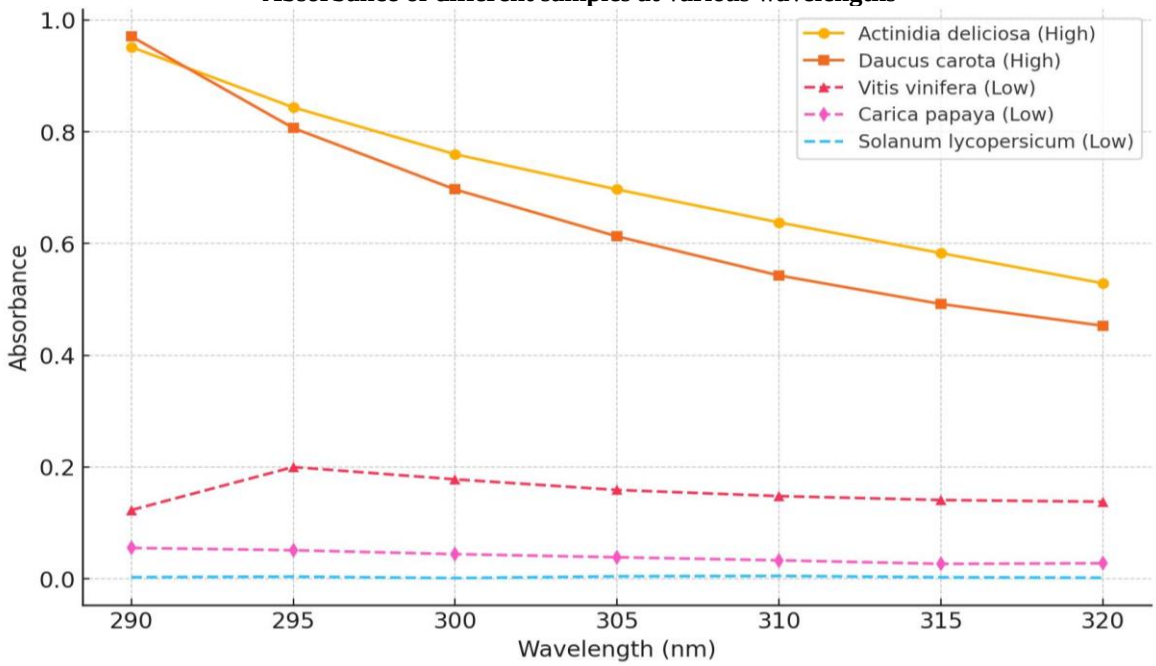
The absorbance of the standard solution was measured at different wavelengths ranging from **290 nm to 320 nm**. The extinction coefficient (*EE*),

intensity (*I*), and corresponding absorbance values are presented in **Table 5** below.

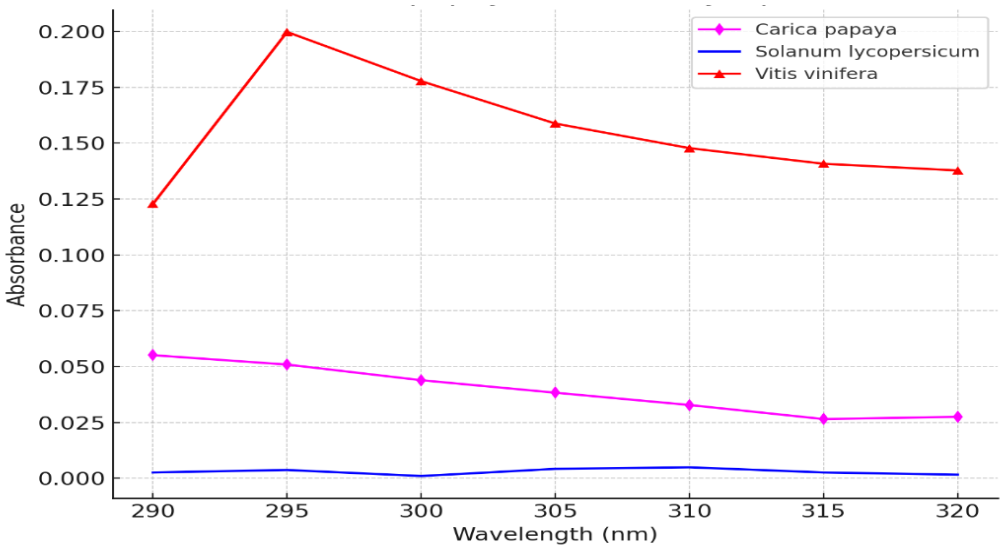
Table 5: Absorbance of Standard and various Samples at Different Wavelengths

S.No	Wavelength (nm)	EE*I	Standard Absorbance	***Actinidia deliciosa***	***Daucus carota***	***Vitis vinifera***	***Carica papaya***	***Solanum lycopersicum***
1	290	0.015	0.310	0.951	0.970	0.122	0.0543	0.0018
2	295	0.0817	0.383	0.843	0.806	0.199	0.0501	0.0029
3	300	0.2874	0.429	0.759	0.696	0.177	0.0431	0.0002
4	305	0.3278	0.477	0.696	0.612	0.158	0.0375	0.0034
5	310	0.1864	0.438	0.637	0.542	0.147	0.0320	0.0041
6	315	0.0837	0.413	0.582	0.491	0.140	0.0257	0.0018
7	320	0.018	0.403	0.528	0.452	0.137	0.0267	0.0008

Absorbance of different samples at various wavelengths



Detailed Absorbance of Solanum lycopersicum, Carica papaya and Vitis vinifera



DISCUSSION:

Percentage Yield of Ethanolic Extracts

The percentage yield of ethanolic extracts varies across different plant species. Actinidia deliciosa exhibited the highest yield at **7.29%**, while Beta vulgaris had the lowest at **3.2%**. The variation in yield can be attributed to differences in the moisture content, phytochemical composition, and solubility of bioactive compounds in ethanol. The relatively high yield in Actinidia deliciosa suggests a rich presence of soluble phytoconstituents, making it a promising candidate for further pharmacological evaluations.

Phytochemical Screening

The phytochemical analysis revealed the presence (+) and absence (–) of various bioactive compounds in the ethanolic extracts. The common constituents found across all plants include **alkaloids, carbohydrates, glycosides, tannins, and phytosterols**. Flavonoids were present in **Beta vulgaris, Carica papaya, and Solanum lycopersicum**, while **saponins were detected in Beta vulgaris, Carica papaya, and Solanum lycopersicum**. The presence of these compounds suggests potential medicinal benefits such as antioxidant, antimicrobial, and anti-inflammatory properties. Notably, Vitis vinifera contained proteins, indicating its possible nutritional and therapeutic value.

Absorbance of Standard

The standard solution showed increasing absorbance with increasing wavelength up to **305 nm (0.477)** before slightly declining. This pattern is consistent with the light absorption behavior of UV-protective compounds. The highest absorbance at **305 nm** suggests the optimal wavelength for potential UV protection.

Absorbance of Ethanolic Herbal Extracts

- **Actinidia deliciosa:** The highest absorbance was observed at **290 nm (0.951)**, with values gradually decreasing at higher wavelengths. This indicates potential UV absorption capabilities, making it a promising candidate for sunscreen formulations.
- **Daucus carota:** Similar to Actinidia deliciosa, it exhibited strong absorbance at **290 nm (0.970)**, suggesting the presence of UV-protective phytoconstituents like carotenoids.
- **Vitis vinifera:** Showed moderate absorbance, peaking at **295 nm (0.199)**, indicating a relatively lower UV protection potential compared to the previous extracts.
- **Beta vulgaris:** The absorbance values were significantly lower, with a peak at **295 nm (0.1914)**. This suggests a lower concentration of UV-absorbing compounds in this plant.
- **Carica papaya:** Displayed the least absorbance across all wavelengths, peaking

at **290 nm (0.0543)**. This suggests minimal UV protection capabilities.

- **Solanum lycopersicum:** The lowest absorbance values were observed, with a peak at **305 nm (0.0034)**, indicating that it does not contribute significantly to UV absorption.

CONCLUSION:

- **Yield Analysis:** Higher extraction yields suggest a greater availability of bioactive compounds, with Actinidia deliciosa and Vitis vinifera being the most promising sources.
- **Phytochemical Presence:** The presence of flavonoids, alkaloids, tannins, and saponins supports the potential antioxidant, antimicrobial, and UV-protective properties of these plants.
- **UV Absorbance:** Actinidia deliciosa and Daucus carota showed the highest UV absorption, making them suitable candidates for potential sunscreen formulations. Conversely, Solanum lycopersicum exhibited the lowest absorption, indicating minimal UV-protective activity.

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