Determination of Sun Protecting Factor Value of Some Vegetable Extracts Using Uv-Visible Spectrophotometer.

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Abstract

This study investigates the determination of Sun Protection Factor (SPF) values in vegetable extracts using UV-visible spectroscopy, and provides a complete appraisal of their potential as natural sunscreens. With increased concerns about the safety and efficacy of synthetic sunscreen chemicals, there is a renewed interest in researching alternative sources, particularly those derived from nature. The investigation includes the extraction of several vegetable samples, followed by UV-visible spectroscopic examination to determine their SPF levels. Methodology included thorough sample preparation, spectral capture, and comparison to commercial sunscreen standards. The results show significant variability in SPF values across different vegetable extracts, indicating differing degrees of photoprotective capabilities. Notably, several extracts have SPF values comparable to commercial sunscreens, indicating their potential as effective natural alternatives.

Also, the study goes to the underlying mechanisms responsible for vegetable extracts' photoprotective benefits, offering information on their potential mode of action against UV radiation. Furthermore, the study investigates factors that influence SPF values, such as extract concentration, solvent composition, and botanical origin, offering useful information for future formulation development. Furthermore, the study looks into the stability and compatibility of vegetable extract-based formulations, which are important factors to consider when developing skincare products.

Overall, this study advances natural sunscreen alternatives by providing a comprehensive assessment of vegetable extracts' SPF effectiveness. The findings demonstrate the viability of incorporating vegetable-derived chemicals into sunscreen formulations, leveraging their inherent photoprotective capabilities. This work bridges the gap between traditional botanical knowledge and current scientific approaches, paving the door for the production of environmentally friendly and safe sunscreen products. Finally, the study of vegetable extracts as natural sunscreens shows promise in meeting customer desire for ecologically friendly and health-conscious skincare solutions.

Introduction

Skin is considered as the longest and peripheral portion of the body and it is helpless to the photodamage because of the coordinate introduction to the sun-oriented radiation including other natural variables. World Health Organisation (WHO) classified ultraviolet light as carcinogenic and also it produces several adverse effects like mutagenicity, accelerated skin ageing, immune depression of the skin and photo dermatoses[1].

World Wellbeing Association (WHO) classified ultraviolet light as carcinogenic additionally it produces several antagonistic impacts like mutagenicity, quickened skin maturing, resistant sadness of the skin and photo dermatoses. Long term Exposure to UV radiation induces the oxidative stress by generating the reactive oxygen species (ROS). UV radiations are classified into UV-A (400nm to 320nm), UV-B (320nm to 280nm) and UV-C (280nm to 100nm)[2]. Among the three radiations UV-C is the foremost deadly to all living life forms because it has tall lively electromagnetic radiation. UV-C is mostly blocked by the ozone layer found within the stratosphere. Stratosphere moreover squares most of the UV-B radiations. As ozone layer is exhausting assurance from UV-B Radiation is picking up incredible significance.

UV-B radiation is the more dangerous to the human pores and skin and more responsible for the erythema of sunburn and suntan of the human skin. While human skin is exposed to the UV-B radiation, It's get absorbed with the aid of DNA of keratinocyte. Exposure to UV rays on the skin can cause skin damage, so protection is important. Protection against light can be achieved through the use of protective measures such as treatment with anti-inflammatory drugs and sun protective clothing[3]. Sunscreen can be used to protect against UV-A and UV-B radiation. Sun protection works mainly by two methods: (i) absorption and (ii) scattering and reflection of UV energy. Today's sunscreens chemical and physical ingredients used to protect against the sun[4]. Market research shows that there are many different sunscreen formulas on the market. These formulas have many sunscreens that work based on their ability to absorb UV rays, but many of these formulas are expensive and contain synthetic ingredients that are very toxic, even carcinogenic. There is increasing interest in the evaluation of antioxidant properties of herbal product and the use of antioxidants in cosmetics[5]. Herbal extracts used in many medicines contain vitamins, alkaloids, flavonoids, phenolic acids and terpenoids therefore, it can be used as a potential preparation for many good skin medicine products, including sunscreen[6].

The production of reactive oxygen species is the main cause of skin damage following UV exposure, so antioxidants are needed to protect the skin. Today, pharmaceutical companies use many natural products, including squalene, peptides, to protects kin from UV radiation[7].

Thus, the objective of present study was to determine SPF values of vegetables and fruits which are used extensively in routine diet. We investigated UV absorption capacity of five vegetables Potato (Solanum tuberosum), Beetroot (Beta vulgaris), Brinjal (Solanum melongena), Cucumber (Cucumis sativus) and Sweet potato (Ipomoea batatas). In addition, we also determined total phenolic content of above-mentioned vegetables.

Sunscreen effectiveness is commonly described as sun protection factor (SPF), which is the ratio of UV energy required to achieve the minimum erythema dose (MED) on protected skin against unprotected skin. A simple, rapid, and reliable in vitro approach for calculating SPF is to measure the product's absorbance at 290-320 nm at 5 nm intervals. SPF can be determined using the Mansour equation[8].

$$SPF = CF \times \sum^{320}{}_{290} EE\ (\lambda) \times \mathrm{I}(\lambda) \times Abs(\lambda)$$

Where,

CF = correction factor (10),
EE = erythemogenic effect of radiation with wavelength,
I = solar intensity spectrum,
Abs (λ) = spectrophotometric absorbance values at wavelength. The values of EE x I (λ) are constants[7].

Wavelength (nm)	EE(λ) x I (λ)
290	0.015
295	0.0817
300	0.2874
305	0.3278
310	0.1864
315	0.0837
320	0.018
Total	**1**

TABLE 01: : Normalized Product Function Used in the Calculation of SPF

Materials and methods

1.Materials

Ethanol, sodium carbonate, Folin–Ciocalteu reagent and gallic acid were provided by the College. All chemicals used in the experiments were of analytical grade, and deionized water was used in the experiments.

2.Instruments

Shimadzu Double Beam UV-Visible Spectrophotometer (Model: UV-19001,Wavelength: 1001100nm) and Mixer grinder.

3.Collection of samples

Five vegetable samples Potato, Beetroot, Brinjal, Cucumber and Sweet potato were purchased from local market (Ashti, Beed, Maharashtra). Vegetables were selected for uniform size, colour and level of external ripeness.

4.Preparation of extract

Fresh vegetables were taken and washed them properly under the tap water and rinsed with distilled water. The vegetables were size reduced with the help of mixer grinder. From the grounded vegetables 20 gm from each were taken separately in a beaker. A solvent mixture was prepared 0 After extraction then it was filtered with Whatman filter paper. The clear solutions obtained after filtration. Then, the filtrate was used as a stock solution for each sample[9].

5.Sample preparation for absorbance measurements

1 mL of the filtrate of stock solution was taken and transferred to a standard 50 mL volumetric flask, diluted to volume with distilled water, so that the sample concentration was 800 ppm[8].

6.Determination of Sun protection factor (SPF) of the extract

From stock solution, serial dilutions were performed to obtain different concentrations of samples (1, 0.50, 0.25, 0.125, and 0.0625 mg/ml) to be analysed for SPF. The SPF was calculated according to the methodology described by *Mansur et*[10]. The absorbance of samples were measured in UV-B wavelength range (290–320 nm), with 5-nm increments using Shimadzu Double Beam UV-Visible Spectrophotometer and 70% methanol as blank[7].

The SPF was calculated by applying the Mansur equation which is mentioned above.

7.Determination of Total phenolic contents

- **Principle**

Phenols are first extracted in water, then reacted with the Folin-C reagent (a complex mixture of heteropolyphosphotungstate molybdate) in the presence of sodium carbonate to form a blue coloured complex. The intensity of the blue colour is proportional to the amount of reactive phenolic compounds in the sample. Phenolic content is determined by measuring the absorbance of the sample solution at 765 nm and comparing with a calibration curve using gallic acid as a standard. The method is able to quantify total polyphenolic content of about 5–100% (w/w) in the extracts. The method will also yield positive results for extracts containing ascorbic acid, amino acids, or sugars[11].

- **Methodology**

The total phenolic content (TPC) was carried out by using the method of Folin-Ciocalteu. An aliquot (least amount) (1 mL) of extracts or standard solution of gallic acid (100, 200, 300, 400, and 500 µg/mL) was added to 25 mL of volumetric flask, containing 10 ml of decontaminated water. A blank reagent using distilled water was prepared. One mL of Folin-Ciocalteu phenol reagent was added to the mixture and shaken. After 5 mins 10 mL of 7.5% Na2CO3 solution was added to the mixture. The volume was then made up to the mark. Upon completion of incubation for 30-45 minutes at room temperature, the absorbance against the reagent blank was determined at 760 nm with an UV-Visible (Shimadzu Japan). TPC was expressed as mg gallic acid equivalents[11].

RESULT AND DISCUSSION

The absorbances of all the samples were recorded and shown in TABLE 02

Wavelength (nm)	EE(λ) x I (λ)	Beet root	Sweet potato	Potato	Cucumber	Brinjal
290	0.015	0.045	1.513	0.911	0.069	0.483
295	0.0817	0.031	1.412	0.629	0.099	0.465
300	0.2874	0.039	1.281	0.481	0.113	0.439
305	0.3278	0.035	1.174	0.364	0.161	0.421
310	0.1864	0.031	1.103	0.349	0.176	0.414
315	0.0837	0.028	1.056	0.337	0.184	0.407
320	0.018	0.009	1.046	0.304	0.198	0.418

TABLE 02 : Absorbance of the samples taken from290nm to 320nm with 5 increment

Sun Protection Factor (SPF) values of the selected samples were calculated using Mansur equation and shown in the TABLE 03 and the comparison of the SPF values of different vegetable extracts were shown in Figure-1

Sr. No.	Vegetable Extract	SPF values
1	Beet root	36.41
2	Sweet Potato	12.23
3	Potato	4.36
4	Cucumber	2.11
5	Brinjal	4.31

TABLE 03: SPF VALUES OF DIFFERENT VEGETABLE EXTRACTS.

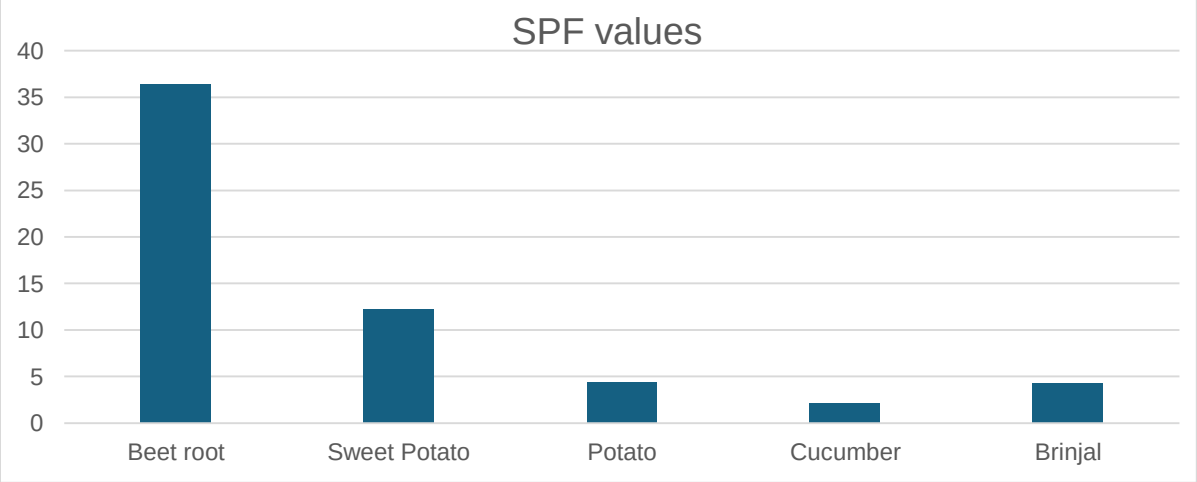

FIGURE-1: Bar graph for SPF values of different vegetable samples.

Total phenolic content of vegetables

Total phenolic content of the selected samples shown in the TABLE-3 and the comparison of the TPC values of different vegetable extracts were shown in Figure-2

Sr. No.	**Vegetable Extract**	Total phenolic content (mg GAE/100 g FW)
1	Beet root	287.71
2	Sweet Potato	39.45
3	Potato	65.50
4	Cucumber	47.13
5	Brinjal	221.64

Table-3: **Total phenolic content of vegetables**

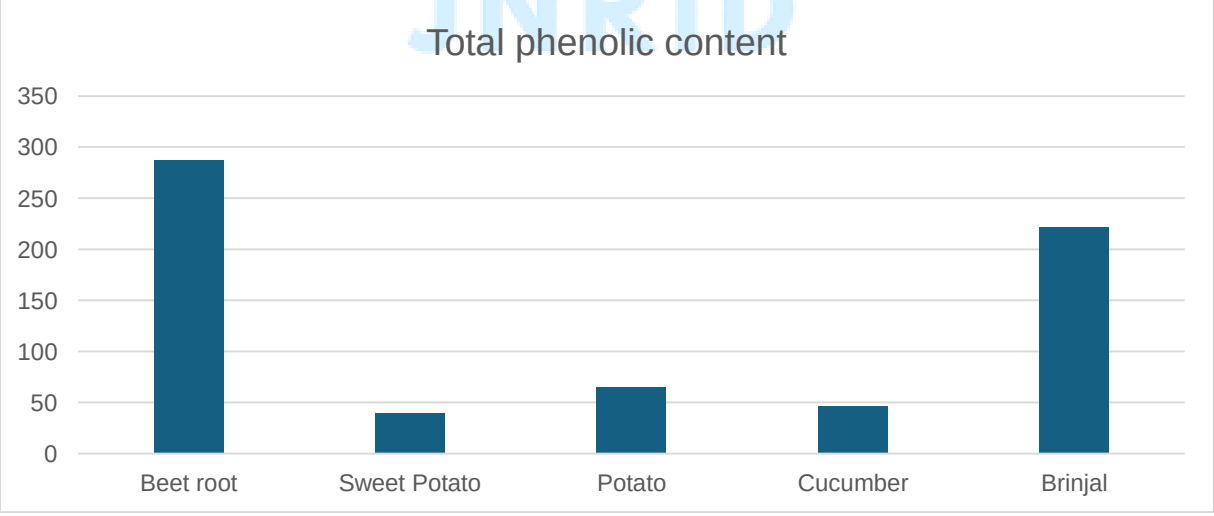

FIGURE-2: Bar graph for Total phenolic contents of different vegetable samples.

Vegetables have number of health benefits and are good sources of flavonoids, phenolics, carotenoids and anthocyanins. Phenolic contents of any plants are directly related to their antioxidant properties[11]. Phenolic chemicals can help reduce and scavenge free radicals by giving hydrogen atoms[12].

The SPF is a system of numbers that rates a sun care product's capacity to offer protection from the sun. Using the in vitro approach, the SPF values of various vegetable extracts were obtained in this study. Every extract displayed a certain SPF value. The calculated SPF values ranges between 2.11 to 36.41. The beet root has highest SPF i.e. 36.41 and cucumber has lowest SPF i.e. 2.11 among the studied samples. As well as every vegetable extracts shows a TPC value The TPC value Ranges From39.45 to 287.71. The Beet root has highest TPC i.e. 287.71 and sweet potato has lowest TPC i.e. 36.41.

Avobenzene is one of the chemical compounds in sunscreen that some people have mild to moderate allergies to. The urinalysis following use may contain traces of avobenzene[13]. Sunscreen must therefore be effective in lowering sunburn risk, but not always cancer risk[14].There are herbal formulations which scatter the incident radiation effectively or absorb the erythemal portion of the suns radiant energy to protect the skin[9].

Conclusion

Total phenolic content values were considerably good for Brinjal among vegetable extracts.
These parameters were directly correlated with the high SPF values of these extracts as well. Brinjal extract showed very high SPF value which could be due to their phenolic contents. Thus, these extracts could be of greater significance in preventing harmful effects of UV radiations and can be used in sunscreen formulations. Further studies should be directed towards the extensive tropical application of these extracts under various conditions of time duration, temperature, light intensity and finding out specific mechanisms. It is also important to find out in which form the formulation will be stable and shows the best effects.

Statement of human and animal rights

This article does not contain any studies with human and animal subjects performed by any of the authors and complied with all ethical standards.

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