

## Determination of Sun Protection Factor (SPF) Number of Some Herbal Extracts

Crețescu Iuliana<sup>1\*</sup>, Chipei D.<sup>1</sup>, Velicevici Giancarla<sup>2</sup>

<sup>1</sup>University of Medicine and Pharmacy "Victor Babes" Timișoara, Faculty of Medicine, Department of Functional Sciences, 2 Eftimie Murgu Sq., 300041 Timisoara, Romania

<sup>2</sup>Banat's University of Agricultural Science and Veterinary Medicine Timisoara, Calea Aradului, no. 119, Timisoara, Romania

\*Corresponding author. Email: iuliana.cretescu@umft.ro

**Abstract** In order to protect our skin from the sun, we use sun protection products to avoid the harmful effects of the UV. The efficiency of the sun protection is expressed by the Sun Protection Factor (SPF). The SPF represents a numeric evaluation system which shows the ability of a product to offer sun protection to a certain extent. In this study, the SPF values of different vegetal extracts were calculated using the "in vitro" method. All the ethanol-based extracts prepared by us presented SPF values. Thus, ethanol-based and water – based plant, fruit and vegetable extracts, at optimum concentrations could produce more beneficial effects for the skin, except the functionality as UV filters, taking into consideration that they act through different mechanisms on the stimulation of the body immunity. Together with other beneficial effects, these vegetable products could become good, cheap and readily available ingredients in the products with photoprotective effect.

**Key words**

SPF, vegetal extracts

The irradiation with UV on the skin level leads to rash, edema, sun burn, hyperplasia, immunosuppression, phot ageing and photo carcinogenesis [14]. In order to protect the skin from the sun we use sun protection products to avoid the harmful effects of the UV, so that currently the photo-chemo-protective products became an important "weapon" in the fight against the unwanted effects of UV. An ideal sun protection product must be safe, inert from chemical point of view, non-irritant, non-toxic, photostable and should provide full skin protection [1, 2, 7].

In general, the sun protection creams based on plants are safe, largely accepted by the consumers and works in ameliorating the process of carcinogenesis [8]. The current studies were made to determine the SPF values of the water-based and ethanolic extracts of some fruits and vegetables frequently found on the market.

The sun protection efficiency is expressed by the sun protection factor (SPF) which is the energy dose from the UV needed to produce a minimum rash on the protected skin vs the unprotected skin:

$$SPF = \frac{\text{Minimum dose of UV for protected skin}}{\text{Minimum dose of UV for unprotected skin}}$$

SPF represents a numeric evaluation system which indicates the ability of a product to offer sun protection. The UV spectrophotometric method is a simple, fast method which uses low cost reactive substances and can be used for the "in vitro" SPF determination for a series of cosmetic products with

photoprotective action. The proposed methodology can be used as fast method for quality control in the production process, for the finished product analysis and can offer important information, preceding the in vitro tests.

The high number of available products containing sun protection substances shows that the people is aware of the effects which appear after overexposure to sun. The efficiency of a sun protection product is expressed usually by the sun protection factor (SPF) [4, 6, 10, 15, 16].

The purpose of this study is to quantify the UV absorption property of the vegetal substances from hydroalcoholic extracts determining the sun protection factor (SPF).

### Material and Method

A simple, fast and relevant method is the in vitro method for the protection factor calculation and consists in determining the absorption in the interval of 290 – 320 nm with a threshold of 5nm. A mathematic equation known as the Mansur equation was developed for the calculation of the sun protection factor. (SPF):

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

where: CF = correction factor, EE ( $\lambda$ ) = eritrogen effect of the radiation with a  $\lambda$  wavelength, Abs ( $\lambda$ ) =

photometric absorption value of the  $\lambda$  wavelength. The value of  $EE \times \lambda$  is a constant [2, 5, 6, 7, 12].

The biologic material presented in this study is made of 7 vegetable samples sourced from the supermarket (4 samples) and from own production (3 samples) from Pincota town, Arad county.

We took in the study 5 samples of hydroalcoholic extracts with photoprotective effect based on calendula, (PE1, PU1 and PU2), sage (PE2) and rosemary (PE3) sourced from naturist products shops from Timisoara, Timis county. These extracts are used to cure various dermatological conditions, skin lesions, and in some cases burns and also known for sun protection activity.

We prepared ethanolic extracts from vegetable according to the protocol presented by Muslek Uddin Mazunder et al. (2018) using ethylic alcohol 99.5% and distilled water. Before preparing the extracts, the samples were washed and grated using a Nutribullet Mixer [10]. The extraction was realized at the ambient temperature overnight, and after that extraction the extract was filtered through a Whatman paper filter. The filtered extracts were centrifuged for 20 minutes at 2000 rpm. The obtained supernatants were stocked in brown color bottles at the ambient temperature in order to determine the physical-chemical properties like SPF. The samples were coded as follows: PD – pumpkin extract; PS – beetroot extract; PA – pepper extract; PM – carrot extract; PCN – normal potato extract; PCD – sweet potato extract; PCS – cucumber extract.

Also, we prepared the water extracts from fruits and vegetables (Aloe vera, Carrot, strawberry and cucumber) were prepared according to the protocol presented by Malsawmtluangi et al. (2013) [9]. The fruits and vegetables used were first washed, mixed with a Nutribullet mixer. For an overnight type extraction we used 20g per 200ml of distilled water.

The obtained extract was filtered using a Whatman paper filter. The filtered products obtained were stocked in brown color bottles at the ambient temperature in order to calculate the SPF. The samples were coded as follows: PALV-Aq – water-based extract of Aloe Vera; PM-Aq – water-based extract of carrot; PC-Aq – water-based extract of strawberry; PCS-Aq – water-based extract of cucumber.

The extracts were processed in a spectrophotometer Cecil CE1021 for UV ray absorption at the range of 290-320 nm.

The experimental results were processed in excel, using a descriptive statistical analysis and they are presented in this study as average values  $\pm$  SD (standard deviation).

## Results and discussions

Table 1 presents the SPF results for the ethanolic extracts prepared in the laboratory:

Table 1. The results related to the absorption of ethanolic extracts prepared in the laboratory

Wavelength - $\lambda$ (nm)	EE( $\lambda$ )*I( $\lambda$ )	ABSORPTION						
		PD	PS	PA	PM	PCN	PCD	PCS
290	0.015	1.794	0.379	0.482	0.796	1.046	1.704	0.432
295	0.0817	1.572	0.369	0.369	0.737	0.815	1.54	0.39
300	0.2874	1.43	0.358	0.292	0.69	0.684	1.454	0.339
305	0.3278	1.338	0.342	0.252	0.657	0.621	1.43	0.318
310	0.1864	1.252	0.321	0.234	0.633	0.593	1.432	0.298
315	0.0837	1.168	0.299	0.226	0.617	0.575	1.464	0.289
320	0.018	1.098	0.282	0.219	0.6	0.562	1.518	0.269

The values  $EE \times I$  are constant and are presented in table 2.

Table 2 Values for  $EE(\lambda)*I(\lambda)$  according to Sayre and colab. (1979)

$\lambda$	EE( $\lambda$ )*I( $\lambda$ )
290	0.015
295	0.0817
300	0.2874
305	0.3278
310	0.1864
315	0.0837
320	0.018

The values obtained for the SPF of the ethanolic extracts prepared in the laboratory are presented in figure 1:

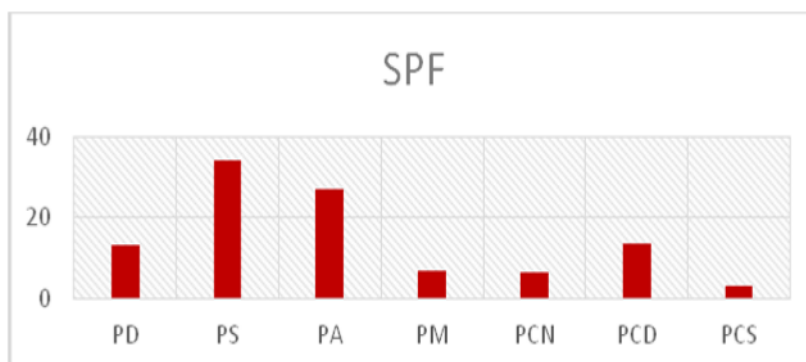


Fig. 1. Results for the SPF of the ethanolic extracts prepared in the laboratory

In figure 2 we presented the SPF results for the commercial ethanolic extracts:



Fig. 2. The SPF results of the ethanolic extracts

In figure 3 we presented the SPF of the water-based extracts:

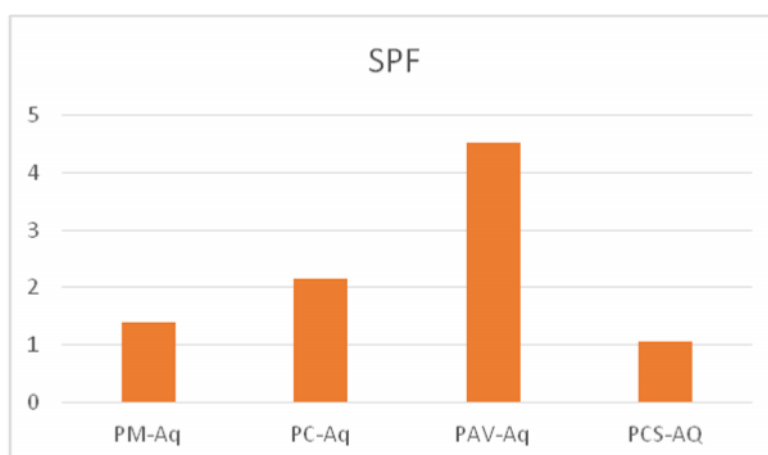


Fig. 3. SPF results for the water-based extracts

SPF is a quantitative approach to measure the efficiency of some products with sun protection effect [13]. Nowadays, the people are more aware regarding the efficiency of the sun protection products. Thus, to be efficient, a product must prevent the sun burns and have a large range of absorption between 290 and 400 nm.

Many times, the *in vivo* tests for the SPF evaluation of different products with photoprotective effects are made with human volunteers [11]. These *in vivo* tests need time and include different variability degrees. The *in vitro* SPF is useful for the screening tests performed during the product development in addition to the *in vivo* measurement.

All the ethanolic extracts prepared by us presented SPF values. The calculated SPF values are between 3.246 and 34.076. The beetroot has the highest SPF from all the studied samples, 34.076. Mazumder et al. (2018) reported a value of 39.48 [10] for the beetroot. From the vegetables we used, the lowest value 3.246 was obtained for the ethanolic extract of cucumber. The specialized literature studies indicate for the cucumber extract a SPF value of 1.45 [9]. From our study you can notice that the pepper, pumpkin and sweet potato present a significant potential of sun protection. The SPF value for the sweet potato is 13.445 units, a comparative value with the specialized studies, 12.23 [10]. Mazumber et al (2018) study provides information stating that different vegetables have sun protection properties and are capable to protect the skin from the harmful effect of different physical – chemical factors [9]. Currently there are on the market several creams and lotions with photoprotective effect but most of them contain also other chemical agents.

The vegetable based cosmetic products must have one or more components with antioxidant properties in order to obtain a good photoprotective effect. We can state that, from obtained SPF point of view, the vegetables offer a sun protection potential and, in the future, they can be incorporated, alone or combined with other components, in different sun protection commercial products.

All ethanol based commercial extracts analyzed by us presented SPF values. The calculated SPF values are between 4.240795 and 13.14043. The ethanol-based calendula extract presented the highest SPF value, 13.14043. Similar result was obtained also for the sage extract, 13.00754. We expected to obtain higher results for the calendula oil, but it is true that we don't know the concentration of the commercial extracts. From our results we can say that our samples have a certain photoprotective effect.

*Calendula officinalis* L. is an important plant from the type Calendula, having multiple medical usage all over the world [11]. Calendula is an annual plant with fast growing, easy to germinate and care for. The calendula flower is frequently used for skin care products due to its efficiency for the rejuvenation of the cells, healing of the wounds, inflammation reduction, skin softening and healing [12].

The calendula flower oil has in its chemical composition a high and diversified quantity of flavonoids: coumarins, quinones, volatile oils, carotenoids and amino acids. The calendula oil has a great potential to neutralize the free radicals' reaction, thus, its usage in the cosmetic products industry can't be ignored thanks to antioxidants actions.

The specialized studies state that a 5% calendula cream has physical-chemical characteristics as the calendula oil: specific weight (0.795 g/ml at 25 °C), viscosity (15 cp), pH (6.8), G = 2.10 mS, and the SPF for this cream formula with calendula oil has a value of 14.84

± 0.16 which shows a good sun protection activity to protect the skin from the sun light and rash [11].

There is no specific evidence in the specialized literature regarding the sun protection factors of the essential oil of *Calendula officinalis* flowers, but it was reported that many persons are using the calendula extract and oil to heal different dermatologic injuries and also in some cases of burns. Mishra AK and colab. 2012, notices that the calendula flower oil has sun protection activity [11].

We can notice that all water-based extracts we analyzed have presented SPF values. The calculated SPF values vary between 1.070716 (cucumber extract) and 4.5235556 (Aloe Vera extract). The water-based Aloe Vera extract had the highest SPF, 4.5235556. C. Malsawmtluangi and colab.. 2013, present SPF values for the water-based Aloe Vera extracts of 1.28 ±0.02 [9]. All other water – based extracts have similar SPF results between them.

In case of the water-based strawberry extract we got a SPF value of 2.145809 which is like those mentioned in the specialized literature: 1.63±0.34 [9]. Thus, these plant or fruit or vegetable-based extracts, at optimum concentration could produce more beneficial effects for the skin, beside the UV filter functionality, taking into consideration that they act through different mechanisms also on the immunity system stimulation.

## Conclusions

We can say that currently the calculation of the SPF is a global standard to quantify the efficiency of the sun protection products, giving in this way an idea how long we can stay exposed to the sun without being affected by the sunlight action. All the analyzed vegetal extracts from the study presented SPF values. The highest SPF values were obtained for the ethanol-based extracts of beetroot, pumpkin, sweet potato and calendula.

In a final conclusion, we can say that all studied extracts have protection capacities against UV radiations. In conclusion, the vegetale based cosmetic products are more suitable for the hypoallergenic skin because they are less irritant and more preferred than the dermo cosmetic treatments prescribed by doctors in case of sun burn, like actinic keratosis etc. In general these vegetale products could become proper, cheap and readily available ingredients in the products with photoprotective effect

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