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Formulation and Determination of Sun Protection Factor In A Cream With Naturally Occurring Traditional Constituents

Brinda Sreelesh^{*1}, Gitika Dhingra¹, Neelam Seervi², Mayur Shinde²

1.NCRD's Sterling Institute of Pharmacy, Nerul, NaviMumbai Maharashtra.

2. Prin. L.N. Welingkar Institute of Management Development and Research, Matunga, Mumbai, Maharashtra.

ABSTRACT

SPF (Sun Protection Factor) measures amount of protection a product provides to the skin from the harmful UV rays of the sun. The present research work deals with determining effectiveness of sunscreen formulations containing naturally occurring herbal actives. Sunscreens with synthetic active ingredients adversely effect the skin in long term while the herbal ingredients have been found to be more effective with fewer side effects. The selected herbs include roots of *Rubia cardifolia*, heartwood of *Prunus cerasoides* and roots of *Vetiveria zizanioides*. Formulations were prepared with each of these selected herbal ingredients in varying concentrations and an integrated preparation using concentrations found most effective. SPF was calculated for all formulations using the spectrophotometric method and then applying the Mansur equation. The results of the study depicted that the integrated formulation containing 25% concentration each of *Prunus cerasoides*, *Rubia cardifolia* and *Veteveria zizanioides* provided maximum sun protection.

Keywords: Sun protection factor, *Rubia cardifolia*, *Prunus cerasoides*, *Veteveria zizanioides*, sunscreen.

*Corresponding Author Email: shaktipalpatil@yahoo.com

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INTRODUCTION

Sunscreens protect the skin by preventing and minimizing the harmful effects of ultraviolet (UV) rays of the sun. UV radiation have a broad spectrum, ranging from 40 to 400nm (30–3eV), which is divided into Vacuum UV (40–190nm), Far UV (190–220nm), UVC (220–290nm), UVB (290–320), and UVA (320–400nm), of which the latter two are medically important. There are two distinct subtypes of UVA radiation. Short-wave UVA (320–340nm) and long-wave UVA (340–400nm), the latter constituting most of UVA radiation. The amount of exposure to UVA usually remains constant, whereas UVB exposure occurs more in the summer. [1]

There has been a considerable increase in the use of sunscreens in the recent years due to increasing incidences of skin cancers, accelerated skin aging and photo dermatoses. This growing awareness of consumers to protect their skin from damaging radiations with products that are effective and safe have flooded the markets with many synthetic and herbal formulations which are priced few hundreds to a thousand rupees. Synthetic UV filters are known to have potential toxicity in humans and also showed ability to interfere only in selected pathways of multistage process of carcinogenesis.[2] Studies have also proved that naturally occurring traditional substances show better effectiveness than the synthetic counterparts. The herbal ingredients are better absorbed into the deeper layers of the cells and hence prove to be more effective at milder concentrations. This in turn also reduces side effects, which are more pronounced in synthetic sunscreens.

Sunscreen formulations were prepared using roots of *Rubia cardifolia*, heartwood of *Prunus cerasoides* and roots of *Vetiveria zizanioides* individually and in combination in the present study.

Rubia cardifolia, well known as Manjishta holds the reputation of a very good skin care herb as is used to make the complexion even and lighten dark spots.[3] Ayurvedic texts enumerate its qualities to be: *Varnya*, *rakta prasādaka*, *rakta śodhaka*(blood purifier). Chemically, it contains glucosides known as Manjisthin and Purpurine, along with resins, lime salts and colouring agents. Methanolic extract of this herb has been reported to show 14.80% mean inhibition of tyrosinase activity thereby acting as skin whitening agent. [4]

The use of Padmaka (*Prunus cerasoides*), as skin care herb is well documented in both Ayurveda (Used in leprosy, leucoderma, erysipelas) and in biomedicine, even then it is not a popular cosmetic herb.[5] Recently, a new flavanone glycoside Puddumin-B, (naringenin-4-methyl-ether -7-O-β-D-galactoside) has been isolated from *Prunus cerasoides* [6] which exhibited anti melanogenesis activity by suppression of tyrosinase protein making it a suitable candidate for skin whitening.[7]

Usira, *Vetiveria zizanioides*, is an ecofriendly, perennial tussock grass that is used traditionally for various ailments but the commercially extracted *Vetiver zizanioides* essential oil (VZ-EO) has extensive applications in cosmetic industries.[8] Over 150 compounds have been isolated from vetiver oil so far,[9] the most abundant component being cedr-8-en-13-ol (12.4%) along with α -amorphene (7.80%), β -vatiene (5.94%), α -gurjunene (5.91%) and dehydro-aromadendrene (5.45%). It has been reported that VZ-EO exhibits significant antioxidant activity and suppresses the β -MSH-induced melanogenesis thereby decreasing melanin production through tyrosinase inactivation and the simultaneous suppression of oxidative stress in B16 melanoma cells.[10] Therefore, VZ-EO has the potential to become an ingredient in future hypopigmentation cosmetics.[11]

The above mentioned herbal drugs belong to the varnya category according to the Charak Samhita. The word *varṇa* in Sanskrit means “outward appearance, exterior form, figure, shape, colour”, “colour of the face”, “good colour or complexion, lustre, beauty.[12] *Varṇa* is not just colour but it includes all the parameters of healthy and radiant skin.[13] The varnya category are complexion enhancers. This study has tried to explore the protection offered by these herbal actives when put into a cream base.

MATERIALS AND METHOD

The crude drugs for the present research were procured from Yucca Laboratories, Mumbai. The roots of *Rubia cardifolia*, heartwood of *Prunus cerasoides* and roots of *Vetiveria zizanioides* were ground into a coarse powder.

Chemicals and Materials:

All the chemicals used for formulation and evaluation were obtained from SD fine chemicals (Mumbai).

Apparatus:

Blue star UV spectrophotometer equipped with 1 cm quartz cell.

Formulation of the sunscreen cream:

The aqueous extracts of roots of *Rubia cardifolia*, heartwood of *Prunus cerasoides* and roots of *Vetiveria zizanioides* were prepared by soaking these coarsely ground crude drugs overnight, boiling them and concentrating them to obtain different concentrations. These extracts were further incorporated into vanishing cream base prepared by boiling and fusion method. Creams containing individual herbal extracts as well as cream formulation containing their combination were prepared.

Evaluation of the cream for sun-screening activity:

Efficacy of sunscreen:

The efficacy of a sunscreen is usually expressed by sun protection factor (SPF), which is the ratio of UV energy required to produce a minimal erythemal dose (MED) in protected skin to unprotected skin. A simple, rapid and reliable *in vitro* method of calculating the SPF is to screen the absorbance of the product between 290-320 nm at every 5 nm intervals. SPF can be calculated by applying the following formula known as Mansur equation. [14] Mishra *et al.*, 2012):

Where CF = correction factor (10), EE (λ) = erythrogenic effect of radiation with wavelength λ , Abs (λ) = spectrophotometric absorbance values at wavelength λ .

The values of EE x I are constants. ¹²⁻¹⁵

Sample preparation:

1.0 g of all samples of the cream was weighed, transferred to a 100 mL volumetric flask, diluted to volume with ethanol, followed by sonication for 5 min and then filtered through cotton, rejecting the ten first mL. A 5.0 mL aliquot was transferred to 50 mL volumetric flask and diluted to volume with ethanol. Then a 5.0 mL aliquot was transferred to a 25 mL volumetric flask and the volume completed with ethanol.

The absorption data were obtained in the range of 290 to 320, every 5 nm, and 3 determinations were made at each point, followed by the application of Mansur equation.

RESULTS AND DISCUSSION

The absorbance and SPF values of the samples calculated using UV-Spectrophotometric method are shown in the table no 1 to table no. 8.

Table 1: Absorbance Readings of 10% Concentration of Prunus cerasoidesin Herbal Cream

Wavelength	ABS	EE*1	ABS*EE*I	SPF
290	0.121	0.015	0.001815	
295	0.089	0.0817	0.0072713	
300	0.077	0.2874	0.0221298	
305	0.065	0.3278	0.021307	
310	0.055	0.1864	0.010252	
315	0.045	0.0837	0.0037665	
320	0.04	0.018	0.00072	
			0.0672616	0.672616

Table 2: Absorbance Readings of 10% Concentration of Rubia cardifoliain Herbal Cream

Wavelength	ABS	EE*1	ABS*EE*I	SPF
290	0.104	0.015	0.00156	
295	0.084	0.0817	0.0068628	
300	0.074	0.2874	0.0212676	
305	0.068	0.3278	0.0222904	
310	0.062	0.1864	0.0115568	

315	0.056	0.0837	0.0046872	
320	0.05	0.018	0.0009	
			0.0691248	0.691248

Table 3: Absorbance Readings of 10% Concentration of Veteveria zizanioides in Herbal Cream

Wavelength	ABS	EE*1	ABS*EE*I	SPF
290	0.123	0.015	0.001845	
295	0.104	0.0817	0.0084968	
300	0.095	0.2874	0.027303	
305	0.089	0.3278	0.0291742	
310	0.081	0.1864	0.0150984	
315	0.073	0.0837	0.0061101	
320	0.07	0.018	0.00126	
			0.0892875	0.892875

Table 4: Absorbance Readings of 25% Concentration of Prunus cerasoidesin Herbal Cream

Wavelength	ABS	EE*1	ABS*EE*I	SPF
290	0.217	0.015	0.003255	
295	0.16	0.0817	0.013072	
300	0.138	0.2874	0.0396612	
305	0.129	0.3278	0.0422862	
310	0.119	0.1864	0.0221816	
315	0.113	0.0837	0.0094581	
320	0.1	0.018	0.0018	
			0.1317141	1.317141

Table 5: Absorbance Readings of 25% Concentration of Rubia Cardifoliain Herbal Cream

Wavelength	ABS	EE*1	ABS*EE*I	SPF
290	0.215	0.015	0.003225	
295	0.176	0.0817	0.0143792	
300	0.151	0.2874	0.0433974	
305	0.134	0.3278	0.0439252	
310	0.119	0.1864	0.0221816	
315	0.107	0.0837	0.0089559	
320	0.1	0.018	0.0018	
			0.1378643	1.378643

Table 6: Absorbance Readings of 25% Concentration of Veteveria zizanioidesin Herbal Cream

Wavelength	ABS	EE*1	ABS*EE*I	SPF
290	0.131	0.015	0.001965	
295	0.102	0.0817	0.0083334	
300	0.091	0.2874	0.0261534	
305	0.088	0.3278	0.0288464	
310	0.081	0.1864	0.0150984	
315	0.078	0.0837	0.0065286	
320	0.07	0.018	0.00126	
			0.0881852	0.881852

Table 7: Absorbance Readings of 50% Concentration of Prunus cerasoidesin Herbal Cream

Wavelength	ABS	EE*1	ABS*EE*I	SPF
290	0.174	0.015	0.00261	
295	0.147	0.0817	0.0120099	
300	0.134	0.2874	0.0385116	
305	0.123	0.3278	0.0403194	
310	0.112	0.1864	0.0208768	
315	0.106	0.0837	0.0088722	
320	0.1	0.018	0.0018	
			0.1249999	1.249999

Table 8: Absorbance Readings of Integrated Cream with 25% Concentration of Prunus cerasoides, Rubia Cardifolia & Veteveria zizaniodes

Wavelength	ABS	EE*1	ABS*EE*I	SPF
290	0.306	0.015	0.00459	
295	0.296	0.0817	0.0241832	
300	0.276	0.2874	0.0793224	
305	0.254	0.3278	0.0832612	
310	0.222	0.1864	0.0413808	
315	0.197	0.0837	0.0164889	
320	0.168	0.018	0.003024	
			0.2522505	2.522505

Table 9: SPF Values of individual and integrated cream consisting of Prunus cerasoides, Rubia cardifolia and Vitiveria zizaniodes

Sr no.	Name of herb	Concentration in %	SPF
1.	Prunus cerasoides	10	0.67
		25	1.32
		50	1.25
2.	Rubia cardifolia	10	0.69
		25	1.38
3.	Vetiveria zizaniodes	10	0.89
		25	0.88
4.	Integrated cream	25+25+25	2.52

The SPF values of the herbal formulations prepared ranged from 0.67 in 10% *Prunus cerasoides* to 2.52 in the 25% integrated cream. The highest SPF was found in 25% concentration cream consisting of 25% each of *Prunus cerasoides*, *Rubia cardifolia* and *Veteveria zizaniodes* (Combination cream). The SPF values of creams containing only one of the actives depicts highest sun protection being offered by *Rubia cardifolia* followed by *Prunus cerasoides* followed by *Vetiveria zizaniodes*.

The suggested mode of action of the cream as an effective sunscreen could be attributed to UV block by the herbs dispersed in the cream base and also the UV absorption by these naturally occurring herbal ingredients. Moreover these herbs have been used for their skin lightening attributes and their antioxidant properties also result in their effectiveness.

The activity of *Prunus cerasoides* could be attributed to a new flavanone glycoside Puddumin-B, (naringenin-4-methyl-ether -7-O- β -D-galactoside) isolated from *Prunus cerasoides*[15] which exhibited anti melanogenesis activity by suppression of tyrosinase protein making it a suitable candidate for skin whitening.[7]

Ayurvedic texts enumerate qualities of *Rubia cardifolia* to be: *Varṇya*, *rakta prasādana*, *rakta śodhaka*(blood purifier). Chemically, it contains glucosides known as Manjisthin and Purpurine, along with resins, lime salts and colouring agents. Methanolic extract of this herb has been reported to show 14.80% mean inhibition of tyrosinase activity thereby acting as skin whitening agent.[4]

It has been reported that *Vetiveria zizanioides* exhibits significant antioxidant activity and suppresses the β -MSH-induced melanogenesis thereby decreasing melanin production through tyrosinase inactivation and the simultaneous suppression of oxidative stress in B16 melanoma cells.[10]

CONCLUSION:

The SPF values of *Prunus cerasoides*, *Rubia cardifolia* and *Vetiveria zizanioides* extracts in aqueous phase were incorporated in a cream base and their SPF was determined. It was found that the integrated product of these selected herbs showed maximum sun protection.

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