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

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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 Vetiveria zizanioides provided maximum sun protection.

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

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Received 17 February 2020, Accepted 04 March 2020

Please cite this article as: Sreelesh B et al., Formulation and Determination of Sun Protection Factor In A Cream With Naturally Occurring Traditional Constituents. American Journal of PharmTech Research 2020.
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 zizaniodes 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: *Varṇya, 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 zizanoides, is an ecofriendly, perennial tussock grass that is used traditionally for various ailments but the commercially extracted Vetiver zizanoides 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-vatirenene (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 varna in Sanskrit means “outward appearance, exterior form, figure, shape, colour”, “colour of the face”, “good colour or complexion, lustre, beauty.”[12] Varna 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 Yuca Laboratories, Mumbai. The roots of Rubia cardifolia, heartwood of Prunus cerasoides and roots of Vetiveria zizanoides 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 zizanoides 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) = erythmogenic 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 cerasoides in 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|       |
Table 3: Absorbance Readings of 10% Concentration of Veteveria zizaniodes 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|

Table 4: Absorbance Readings of 25% Concentration of Prunus cerasoides in 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|

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|

Table 6: Absorbance Readings of 25% Concentration of Veteveria zizaniodesin 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|

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

| Wavelength | ABS  | EE*I  | 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     |       |

1.249999

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

| Wavelength | ABS  | EE*I  | 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 Vetiveria 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 Vetiveria 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 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]

It has been reported that Veteveria zizaniodes 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 Veteveria zizaniodes 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.

ACKNOWLEDGEMENT:

I would like to express my gratefulness to Dr. M.S. Gadge, Principal of NCRD’s Sterling Institute of Pharmacy for his guidance and encouragement during the research work.

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