Asian Journal of Pharmaceutical and Health Sciences
www.ajphs.com

Development and evaluation of Herbal Sunscreen Formulation

Swathimol S*, Keziya Mary Shaji, Arya Prasad, Deepa S Nair, Deepa Cherian

College of Pharmaceutical Sciences, Government Medical College, Thiruvananthapuram, Kerala, India.

ARTICLE HISTORY

Received: 13.07.2022

Accepted: 07.08.2022

Available online: 30.09.2022

DOI:

10.5530/ajphs.2022.12.17

Keywords:

Herbal oils, Sunscreen, Emulgel,
Sun protection factor.

***Corresponding author:**

Email : swathimol333@gmail.com

ABSTRACT

Solar radiations will produce both beneficial and deleterious effects on the skin. When the skin is exposed to solar radiation for a long time it will produce various harmful effects. Sunscreens are intended to protect the skin from these harmful effects. The sunscreen agents in the formulation may scatter, reflect or absorb UV radiations and prevent its penetration into the skin and thereby skin damage. The efficacy of sunscreen is expressed by Sun protection factor (SPF).A higher value of SPF indicates more protective effect of sunscreen. In this study, the SPF of few herbal oils were determined and the one with high SPF value was selected and formulated. The samples were evaluated for *in vitro* SPF, physical appearance, presence of unwanted substances, pH, viscosity and spreadability. The *in vitro* SPF is determined according to the spectrophotometric method of Mansur *et al.*

INTRODUCTION

The exposure of skin to UV radiation causes severe skin problems like acute sunburn, solar erythema, pigmentation, wrinkles etc. Sunscreens are used to protect the skin from harmful UV radiation. Herbal extracts and oils have different effects, such as antioxidant, sun blocking, anti-inflammatory, antiseptic, emollient, anti-seborrheic, antibacterial, immunomodulatory etc [1]. The herbal molecules are potent candidates for development of formulations because of their fewer side effects. Plants are known as an attractive option to be used in sunscreen formulations due to their antioxidant potential for the prevention of skin damage due to solar radiation [2]. Several herbal oils such as oils of almond, avocado, coconut, cottonseed, olive, peanut, sesame and soybean, have been reported to have UV filters [3]. Because of low bioavailability and high molecular weight they require novel delivery systems for their formulation. Major drawback of topical dosage form is dissolution, diffusion of drug in the delivery of hydrophobic drugs, and permeation through stratum corneum of hydrophilic drugs. Emulgel is a better approach to overcome these problems [4].Emulgels for dermatological use have several favourable properties such as being thixotropic, greaseless, easily spreadable, easily removable, emollient, non-staining and transparent with long shelf life & pleasing appearance [5]. The aim of present research work was to develop and evaluate sunscreen emulgel formulation with herbal oil and optimize the formulation using two gelling agents, Carbopol 934 and HPMC.

MATERIALS AND METHODS

Materials

Herbal oils such as almond oil, coconut oil, sesame oil and sunflower oil were purchased from local market. Carbopol 934, Hydroxypropyl methyl cellulose, Tween 20, Span 20, Propylene glycol, Methyl paraben, Ethanol, n-hexane and Acetone of analytical grade were used.

In vitro determination of SPF of herbal oils

The solubility of the herbal oils in different solvents was determined and maximum solubility was found in n-hexane. The SPF is a quantitative measurement of the effectiveness of a sunscreen formulation. The SPF values of different herbal oils were determined by Mansur *et al*. method. Initial stock solution was prepared by taking 1% v/v of oil in n-hexane, from this stock solution 0.1% solution was prepared. Thereafter, absorbance

values of each aliquot prepared were determined from 290-320 nm, at 5 nm intervals, taking n-hexane as blank, using JASCO V-560 UV-Visible spectrophotometer. The SPF was calculated by using the Mansur equation [6].

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

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×I are constant.

Development of formulation

Emulgel was prepared in two steps, first the preparation of emulsion and then incorporation of emulsion into the gel phase. Carbopol 934 or HPMC was dispersed in distilled water to form the gel phase. The oil phase is prepared by dissolving span 20 in herbal oil. Aqueous phase is prepared by mixing a solution of tween 20 in purified water and methyl paraben in propylene glycol. Both oil phase and aqueous phase was heated to 70^0C and oil phase was added to aqueous phase with constant stirring to form homogeneous dispersion [7]. This emulsion was added to the gel phase to obtain emulgel. Six formulations were prepared using Carbopol 934 (F1, F2, and F3) and HPMC (F4, F5 and F6) as gelling agent. The composition of emulgel formulation is given in the table 1.

Evaluation of formulation

The *in vitro* determination of SPF of sunscreen formulations was done by Mansur *et al* method [6].The formulation was found to be soluble in ethanol, therefore ethanol was taken as the solvent for the determination of SPF. 1.5g of formulation was dissolved in 15ml of ethanol and was centrifuged at 1000rpm for 1hr.The supernatant was collected. The absorbance of samples was recorded in the range of 290-320 nm, every 5 nm interval taking ethanol as blank using a JASCO V-560 UV-Visible spectrophotometer. The SPF was calculated by using the Mansur equation.

The physical appearance of the prepared emulgel formulations were evaluated by visual inspection of colour, homogeneity, grittiness and phase separation.The presence of unwanted substances was determined by taking a small quantity of emulgel, spread on a grease free glass slide and observed against diffused light to make sure the presence of foreign particles. The pH of formulations were determined using a digital pH meter. 0.5gm of sample was dissolved in 50ml of distilled water then pH measurement was taken in triplicate and averages were calculated [8].Viscosity of the formulations was measured by the Brookfield viscometer. The correct spindle was selected (spindle no.7) for the given product then the operating condition was setup. Then the viscosity was measured in triplicate directly at 100 rpm speed. The mean was obtained [9].

The spreadability apparatus consists of a wooden block, which is attached to a pulley at one end. Spreading coefficient (Spreadability) was measured on the basis of 'Slip' and 'Drag' characteristics of emulgels. A ground glass slide was fixed on the wooden block. An excess of emulgel (about 2 g) under study was placed on this ground slide. The emulgel preparation was then sandwiched between this slide and second glass slide having same dimension as that of the fixed ground slide. The second glass slide is provided with the hook. Weight of 500 gm was placed on the top of the two slides for 5 min to expel air and to provide a uniform film of the emulgel between the two slides. Measured quantity of weight was placed in the pan attached to the pulley with the help of hook. Time in seconds taken by two slides to slip off from emulgel is noted. Lesser the time taken for separation of two slides, better the spreadability [10]. It is calculated by using the following formula-S = M*L / T .Where, M = weight tied to upper slide; L = length of glass slides; T = time taken to separate

Table 1 : Composition of emulgel formulation

INGREDIENTS %w/w	F1	F2	F3	F4	F5	F6
Carbopol 934	1.25	1.5	1.75	-	-	-
HPMC	-	-	-	1.25	1.5	1.75
Herbal oil	5	5	5	5	5	5
Span 20	1.5	1.5	1.5	1.5	1.5	1.5
Tween 20	1	1	1	1	1	1
Propylene glycol	5	5	5	5	5	5
Methyl paraben	0.03	0.03	0.03	0.03	0.03	0.03
Purified water	Qs	qs	qs	qs	qs	Qs

the slides. In present experiment M= 30 gm and L= 5 cm. For the determination of extrudability, emulgel formulations were filled in the standard capped collapsible aluminium tubes and sealed by crimping the ends. The weight of the tubes was recorded. The tube was placed between two glass slides and was clamped. A 500gm weight was placed over the glass slides and then the cap was removed. The amount of cream extruded was collected and weighed. The percentage of formulation extruded was calculated [11].

RESULTS

The absorbance and corresponding SPF values obtained for different herbal oils are given in table 2. Out of these herbal oils taken, the SPF value of coconut oil was found to be the highest. Hence it was selected for the formulation of sunscreen emulgel. Due to poor consistency of formulations with HPMC it was neglected from further evaluations. Carbopol 934 based formulations F1, F2 and F3 was evaluated for SPF value, physical appearance, pH, viscosity, spreadability and extrudability.

The results of the physicochemical properties such as pH, viscosity, spreadability and extrudability are summarized in the table 4. All the three formulations F1, F2 and F3 showed acceptable SPF values. The SPF values of the formulations are given in table 3. The formulation F2 was found to have greater SPF value. The formulated emulgels were examined for their colour, homogeneity, consistency and phase separation after 24 hrs of preparation. They were white with a smooth homogeneous appearance and there was no significant phase separation observed in the formulations. All the formulations were free from foreign particles. The pH of the formulations were found in the range 4.48 - 4.60, which matches with the normal pH range of the skin and thus do not produce any skin irritation.

The viscosity of formulations was determined using Brookfield Viscometer and was found to be in range of 10000-23000cP which indicates good rheological properties. An increase in viscosity was observed in the formulations due to increase in the concentration of carbopol. The results was in accordance with that reported by Sah *et al.* The spreadability of formulated emulgels was determined which indicates how easily the emulgel will spread when applied on to the skin and was found to range from 1.36-2.27, F1 showed better spreadability. The spreadability was found to decrease with increase in concentration of gelling agent due to increased viscosity. Extrudability was calculated by the force required to extrude the emulgel from the aluminium collapsible tube on application of weight in grams. In the present study the quantity in percentage of cream extruded from the tube on application of certain load was measured. It is done in triplicate and the average values are calculated. Results show that all the formulations have good extrudability. The extrudability rises with the increase in viscosity of the formulation. That is the formulation with higher concentration of carbopol required low extrusion pressure.

DISCUSSION

As there is an increasing prevalence of harmful effects of solar radiations worldwide the development of herbal sunscreens becomes crucial. Herbal products are widely accepted in the field

Table 2 : Absorbance and SPF values obtained for Sesame oil, Almond oil, Sunflower oil, and Coconut oil.

		Absorbance			
Wavelength (nm)	EE × I (λ)	Sesame oil	Almond oil	Sunflower oil	Coconut oil
290	0.0150	0.4431	0.0416	0.2088	0.5534
295	0.0817	0.3990	0.0252	0.1732	0.4787
300	0.2874	0.3096	0.0183	0.1508	0.3879
305	0.3278	0.2647	0.0157	0.1298	0.3035
310	0.1864	0.2380	0.0121	0.1110	0.2129
315	0.0837	0.2248	0.0114	0.0999	0.1447
320	0.0180	0.2129	0.0095	0.0910	0.0904
SPF value		2.816±0.05	1.202±0.03	1.335±0.02	3.115±0.04

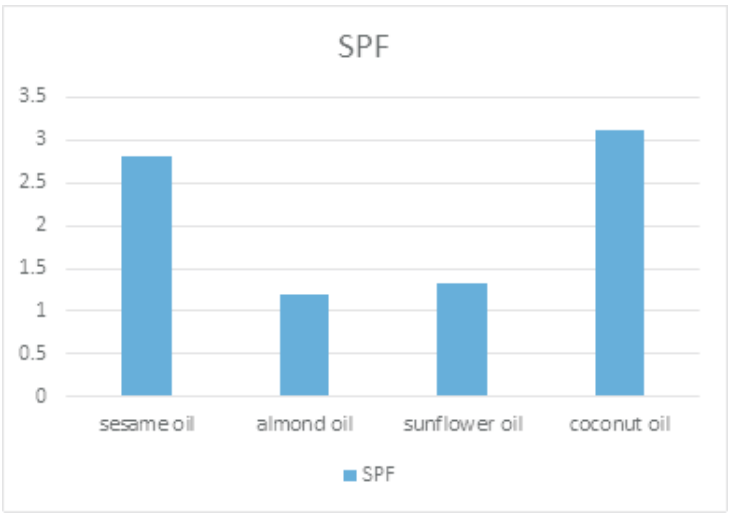

Fig. 1 : SPF values obtained for Sesame oil, Almond oil, Sunflower oil, and Coconut oil.

Table 3 : SPF values obtained for different formulations F1, F2 and F3.

Wavelength (nm)	EE × I (λ)	F1	F2	F3
290	0.0150	2.4788±0.017	3.4676±0.021	3.3213±0.019
295	0.0817	2.4561±0.022	3.4059±0.016	3.2769±0.017
300	0.2874	2.4391±0.014	3.3487±0.021	3.2318±0.024
305	0.3278	2.4189±0.081	3.2944±0.074	3.1804±0.016
310	0.1864	2.4004±0.015	3.2442±0.014	3.1447±0.021
315	0.0837	2.3839±0.023	3.2066±0.012	3.1079±0.018
320	0.0180	2.3660±0.016	3.1738±0.014	3.0837±0.022
SPF		2.4209±0.020	3.3026±0.015	3.1905±0.021

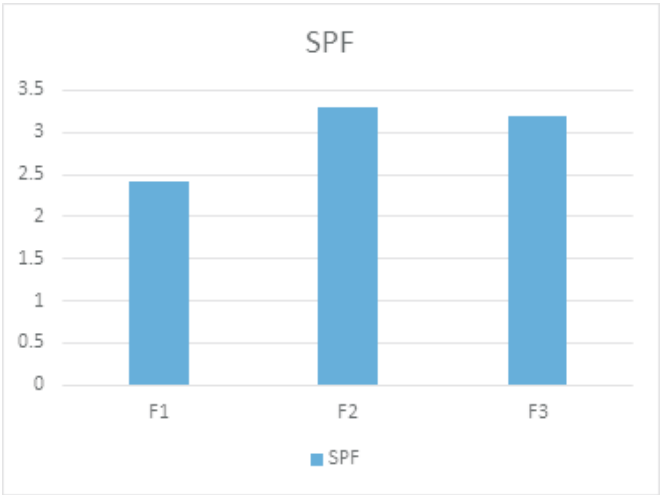

Fig. 2 : SPF values obtained for different formulations F1, F2 and F3.

Table 4 : The pH, viscosity, spreadability and extrudability obtained for different formulations F1, F2, F3.

Formulation	F1	F2	F3
pH	4.48±0.01	4.52±0.02	4.60±0.1732
Viscosity (centipoise)	10600±76.4	16600±55.6	22850±83.6
Spreadability (gm.cm/sec)	2.2727±0.03	1.8750±0.01	1.3636±0.04
Extrudability (%)	97.0734±0.73	97.7986±0.84	98.0797±0.79

of cosmetics due to the absence of synthetic agents and lesser side effects. The present study focused on the development of a herbal sunscreen with a herbal oil as the sun protective agent. This study evaluated the sun protective effect of different herbal oils. The SPF values are calculated for Sesame oil, Almond oil, Sunflower oil, and Coconut oil from the absorbance values obtained. Of these coconut oil which showed highest SPF value was formulated as sunscreen emulgel.

The commercial formulations of sunscreen are usually presented in the form of gel, cream, spray or other topical products [12]. Emulgel can be the alternative for cream or they can be better dosage form to deliver the drug than other conventional semi-solid preparations for hydrophobic drugs in topical treatment. The formulation was optimized by studying the effect of different gelling agents on the SPF and physicochemical properties of the emulgel. The emulgel was formulated by using HPMC and Carbopol 934 as gelling agents at varying concentrations. Due to poor consistency of formulations with HPMC, Carbopol 934 based emulgel formulations were selected for further evaluations.

The optimized product was evaluated for SPF value, physical appearance, pH, viscosity, spreadability and extrudability.

CONCLUSION

In the present study we have formulated herbal sunscreen as emulgel with coconut oil as the active ingredient and evaluated formulations with varying concentration of different gelling agents. From the results obtained it was found that formulations with HPMC was not stable. The formulations F1, F2 and F3 were prepared by varying the concentrations of carbopol and evaluated for their physicochemical properties and SPF value. All the three formulations showed good physical appearance, spreadability, extrudability and the pH was found to match with the normal skin pH. The viscosity found to be increased with the increase in concentration of carbopol. The formulations F1, F2 and F3 showed acceptable SPF values.

REFERENCES

1. Aswal A, Kalra M, Rout A. Preparation and evaluation of polyherbal cosmetic cream. *Der Pharmacia Lettre*. 2013;5(1):83-88.
2. Korać RR, Khambholja KM. Potential of herbs in skin protection from ultraviolet radiation. *Pharmacognosy reviews*. 2011;5(10):164.
3. Kostyuk V, Potapovich A, Albuhaydar AR, Mayer W, De Luca C, Korkina L. Natural substances for prevention of skin photoaging: screening systems in the development of sunscreen and rejuvenation cosmetics. *Rejuvenation Research*. 2018;21(2):91-101.
4. Usha A, Mamatha HS, Banupriya MR. Formulation and Evaluation of Etoricoxcib Emulgel for Topical Delivery. *Journal of Pharmaceutical Sciences and Research*. 2020;12(7):885-9.
5. Stanos SP. Topical agents for the management of musculoskeletal pain. *Journal of pain and symptom management*. 2007;33(3):342-55.
6. Kaur CD, Saraf S. In vitro sun protection factor determination of herbal oils used in cosmetics. *Pharmacognosy research*. 2010;2(1):22.
7. Sreevidya VS. An overview on emulgel. *International Journal of Pharmaceutical and Phytopharmacological Research*. 2019;9(1):93-4.
8. Aswal A, Kalra M, Rout A. Preparation and evaluation of polyherbal cosmetic cream. *Der Pharmacia Lettre*. 2013;5(1):83-8.
9. Djiobie Tchienou GE, Tsatsop Tsague RK, Mbam Pega TF, Bama V, Bamseck A, Dongmo Sokeng S, Ngassoum MB. Multi-response optimization in the formulation of a topical cream from natural ingredients. *Cosmetics*. 2018;5(7):1-14.
10. Mulye SP, Wadkar KA, Kondawar MS. Formulation development and evaluation of Indomethacin emulgel. *Der pharmacia sinica*. 2013;4(5):31-45.
11. Donglikar MM, Deore SL. Development and evaluation of herbal sunscreen. *Pharmacognosy Journal*. 2017;9(1).
12. Glaser KS, Tomecki KJ. Sunscreens in the United States: current status and future outlook. Sunlight, Vitamin D and Skin Cancer. 2020:355-79.

Cite this article : Swathimol S, Keziya Mary Shaji, Arya Prasad, Deepa S Nair, Deepa Cherian
Development and evaluation of Herbal Sunscreen Formulation
Asian J. Pharm. Hea. Sci.. 2022;12(1):2689-2693. DOI : 10.5530/ajphs.2022.12.17