ORIGINAL ARTICLE

Formulation and Evaluation of Sunscreen Cream

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Abstract

Aims: The purpose of sunscreen (anti-sunburn and suntan) preparations is to assist the skin's painful effects, and the purpose of anti-burn preparations is to minimize the harmful effects of sunburn. The materials that are used for the above purpose are known as sun tanning agents and sunburn preventive agents, respectively. In combination, these are known as sunscreens. **Materials and Methods:** Ingredients such as zinc oxide, raspberry oil, jojoba oil, shea butter, glycerin, liquid paraffin, tween 80, methyl paraben, rose oil, and distilled water were used. The zinc oxide, raspberry oil, and jojoba oil were used as sunscreen agents; shea butter and liquid paraffin and polyethylene glycol were used as emollients; glycerin was used as a glossy-effect and moisturizing agent; Tween 80 was used as surfactant; methyl paraben was used as preservative; rose oil was used as flavoring agent; and distilled water was used as aqueous phase. A total of six formulations were developed with different compositions of ingredients, ranging from F1 to F6, to select the best formulation for the advancement scope of the study. The prepared formulations were evaluated for suitable parameters such as physical appearance/visual inspection, skin irritation, determination of pH, perfume stability, spreadability, viscosity, and sun protection factor (SPF). **Results and Discussion:** All the formulations showed a white appearance with a pleasant odor and good perfume stability. The pH for F1 to F6 was in the range of 6.3–7.0, and all the formulations did not show any skin irritation, and spreadability ranged from average to very good. The viscosity values range between 5020 cp and 8912 cp. For the SPF, an *in vitro* method was performed using the Mansur equation. **Conclusion:** By considering the values from the evaluation of all from F1 to F6, the F6 formulation was selected as the best formulation.

Key words: Jojoba oil, raspberry oil, sunscreen agents, sunscreen, sunburn preventive agents, viscosity, sun protection factor, zinc oxide

INTRODUCTION

Sunlight is vital for all living beings; it is required for the formation of Vitamin D, circulation of blood, formation of hemoglobin, etc. Exposure to sunlight on the human body may exhibit beneficial and harmful effects depending on the length and frequency of exposure.

The purpose of sunscreen (anti-sunburn and suntan) preparations is to assist the skin's painful effects, and the purpose of the anti-burn preparations is to minimize the harmful effects of sunburn. The materials that are

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used for the above purpose are known as sun tanning agents and sunburn preventive agents, respectively. In combination, these are known as sunscreens (also known as sunblock, suntan lotion)

Sunrays reaching the surface of the earth contain visible rays (wavelength between 400 and 760 nm), ultraviolet (UV) rays with shorter wavelength (between 220 and 400 nm), and infrared rays with longer wavelength (between 760 and 5,100 nm). The lower the wavelength, the more energy the rays have. UV rays, particularly below 320 nm, are responsible for most of the therapeutic as well as most of the detrimental effects of sun rays on the human body, which depend on the length and frequency of exposure, intensity of the sunlight, and individual sensitivity also concerned.

The best sunscreens protect against both (ultraviolet B [UVB] radiation with wavelength between 290 and 320 nm), which can cause sunburn, and ultraviolet A (UVA) (between 320 and 400 nm), which damages the skin with more long-term effects, such as premature skin aging and skin cancer. Most sunscreens work by containing either an organic chemical compound that absorbs UV light (such as oxybenzone) or an opaque material that reflects light (such as titanium dioxide, zinc oxide), or a combination of both. Typically, absorptive materials are referred to as chemical hillocks, whereas opaque materials are mineral or physical blocks. Before the 1920s, skin color was an important indicator of one's social status in European and Eastern Asian countries. Pale skin was a widely accepted indicator of upper-class status.

The first commercially available sunscreen product was introduced by L'Oreal founder E. Schueller in 1936. During World War II (1939–1945), large numbers of US servicemen in the Pacific theater were exposed to the adverse effects of the tropical sun. Severe sunburn imposed a serious problem. At the time, the military used red petrolatum as a sunscreen.

Sun tanning agents are those sunscreens that absorb a minimum of 85% ultra-violet radiation of the wavelengths of 290–320 nm, but which transmit ultra-violet radiation of wavelengths longer than 320 nm and produce a light transient tan. The sun tanning depends on one's capacity to produce pigment, melanin.

There are three types of skin tanning:

- Immediate tanning: It is elicited by radiations of wavelength of 300–660 nm at 1–10 h of sun exposure, and effects fade within 2–3 h of exposure.
- Delayed tanning: It is stimulated by radiations of wavelength of 290–320 nm at long exposure and fades within 100–200 h.
- True tanning: It is also known as melanogenesis and starts about 2 days after exposure and reaches maximum in about 2–3 weeks.

Sunburn and suntan preparations are classified as sunscreen preparations, palliative preparations, and simulative preparations. Sunscreens' preparation absorbs the erythemal portion of the sun's radiation energy and scatters the incident light effectively. Opaque powders such as zinc oxide and titanium dioxide, either in a dry state or in a vehicle, will serve to scatter the UV light effectively falling upon it.

Palliative preparations are used for the relief of irritation and other problems caused by sunburn. This generally contains antiseptics because in sunburn, bacterial infection chances are higher than in a steam burn case, and because damage to skin cells is involved in sunburn.

Simulative preparations are artificial sunscreen preparations. The purpose is to enhance the cooler to prevent skin damage by absorption of the erythemal radiation. An artificial suntan is obtained by staining the skin. Several natural materials like henna, walnut juice, olive oil extracts, etc., and now mostly synthetic staining materials are used.

Sunburn preventive agents are those sunscreens that absorb more than 95% of UV radiation of the wavelength of 290–320 nm. There is another type of sunburn preventive agents that scatter the sunlight. These include titanium dioxide, kaolin, talc, zinc oxide, calcium carbonate, and magnesium oxide.

There are two factors that are responsible for the natural protection of skin against sunburn.

a. Thickness of the stratum corneum.
b. Pigmentation of the skin: The increase in melanin content of the epidermis increases the protection of the skin.[1,2]

The ideal skin screen must absorb a range of UV rays causing sunburn, should be stable in the presence of sunlight and offer complete protection for the skin, safe, effective, chemically inert. It should be able to block the sun for several hours, against UVB and UVA radiation and offer anticancer properties.[3]

MATERIALS AND METHODS

Materials

Zinc oxide (Techinstro chemicals), jojoba oil (Blend it Raw Apotherapy), and raspberry oil (RV Essential) were used as sunscreen agents, shea butter and liquid paraffin (Reagent shine pvt. Ltd) as emollients, glycerin (standard deviation [SD] fine chemicals) as glossy-effect and moisturizing agent, Tween 80 (SD fine chemicals) as surfactant, methyl paraben as preservative, and rose oil (Banjaras touch of nature) as flavoring agent.

Preparation of sunscreen cream

In a heat-resistant container, initially melt the weighed amount of Shea butter in a china dish in a water bath in descending

Figure 1: Preparation of sunscreen cream

Figure 2: Determination of pH for the prepared formulations

Figure 3: Determination of pH of formulations using pH paper

order of their melting point with continuous stirring till it melts completely around 80°C. Then add the remaining ingredients such as raspberry oil, jojoba oil, and liquid paraffin. In a separate container, heat the water phase, which contains water and glycerin, then slowly add Tween 80 to the water phase until it reaches the same temperature. Once both phases are at the same temperature, slowly combine the oil phase with the water phase. The stirring continuously to form smooth emulsion once mixture was cooled add zinc oxide for sun protection, ensuring it is evenly dispersed into the cream finally add rose oil for fragrance and additional skin benefit, stir well to incorporate all ingredients then allow the cream to cool completely then this mixture was poured into a clean container and to facilitate smooth hydrating cream with effective UV protection. The preparation was shown in Figure 1.[4-7]

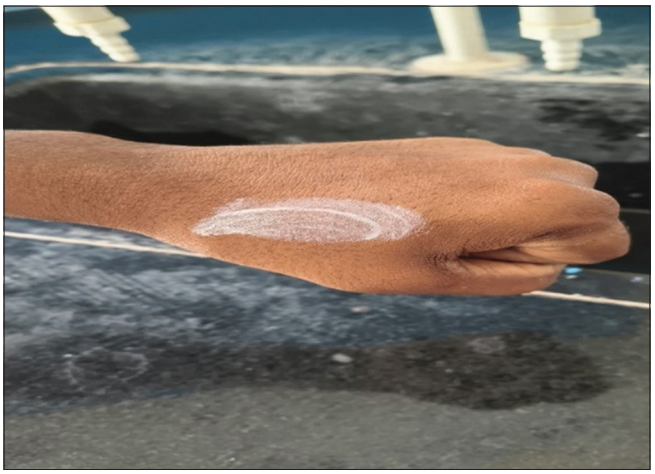

Figure 4: Performing the skin irritation test for the prepared sunscreen cream

Evaluation[8-10]

Physical appearance/visual inspection

The formulation was prepared and observed for colour, odor, appearance, and stability.

- Color: The prepared Sunscreen was evaluated for its colour. The color was checked visually
- Odor: Odor was found by smelling the product
- Stability: The product was maintained in different temperature conditions to check its stability.

Determination of pH

Two grams of sunscreen were taken in a 50 mL beaker. Take the pH paper and put the sample on the pH paper to determine the PH.

Skin irritation

It is carried out by applying sunscreen on the skin for 10 min.

Table 1: Formulation and composition of sunscreen cream

S. No.	Name of the ingredients	F1	F2	F3	F4	F5	F6
1	Zinc oxide	10 g	10.5 g	11 g	11.5 g	12 g	12.5 g
2	Raspberry oil	5 mL	5.25 mL	5.5 mL	5.75 mL	6 mL	6.25 mL
3	Jojoba oil	3 mL	2.5 mL	2.2 mL	1.5 mL	1 mL	0.5 mL
4	Shea butter	25 g	25 g	20 g	20 g	15 g	15 g
5	Glycerin	5 mL	5 mL	5 mL	5 mL	5 mL	5 mL
6	Liquid paraffin	5 mL	5 mL	5 mL	5 mL	5 mL	5 mL
7	Tween 80	1 mL	1 mL	1 mL	1 mL	1 mL	1 mL
8	Methyl paraben	0.5 mg	0.5 mg	0.5 mg	0.5 mg	0.5 mg	0.5 mg
9	Rose oil	QS	QS	QS	QS	QS	QS
10	Water	45.5 mL	45.25 mL	49.8 mL	48.75 mL	54.5 mL	54.25 mL

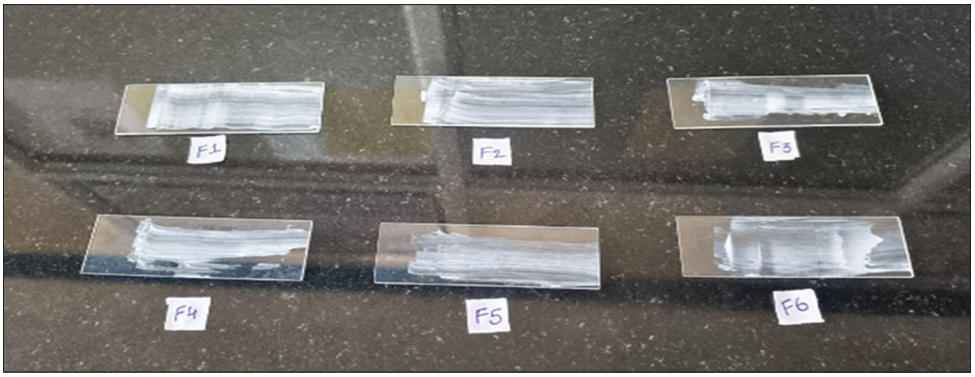

Figure 5: Spreadability test performed on slides for prepared formulations

Figure 6: Viscosity test performed for prepared formulations using the Brookfield viscometer

Perfume stability

After 30 days, the sunscreen cream underwent testing to record its fragrance.

Spread ability test

Good Consistent, if prepared sunscreen cream does not leave pieces, flawless application does not cause the sunscreen cream to deform. Intermediate consistent, if few fragments are left behind, proper application, and minimal sunscreen cream deformation.

Bad: If sunscreen is severely deformed, application is difficult or improper, and there are numerous fragments left behind.

Viscosity

The formulation is an oil-in-water emulsion; hence, the viscosity was low, resulting in rapid release of the complete drug in 6 h. It is seen that among all the formulations, F6 showed higher viscosity compared to the other formulations. Those values ranged between 5020 cp and 8912 cp. The viscosity of the formulations.

Determination of sun protection factor (SPF)

The efficacy of a sunscreen is expressed by the SPF. An *in vitro* method of determining SPF of the sunscreens uses the Mansur equation.

Procedure

Weigh about 2.0 g of the sample in a 100 mL volumetric flask and add methanol to about 3/4th the volume of the flask. Sonicate the contents for about 15–20 min and bring up to the

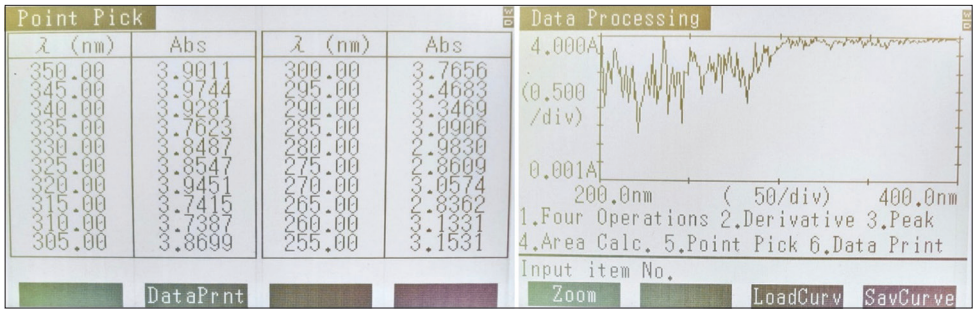

Figure 7: F1 formulation absorbance data obtained by the ultraviolet method, ranging from 290 to 320 nm

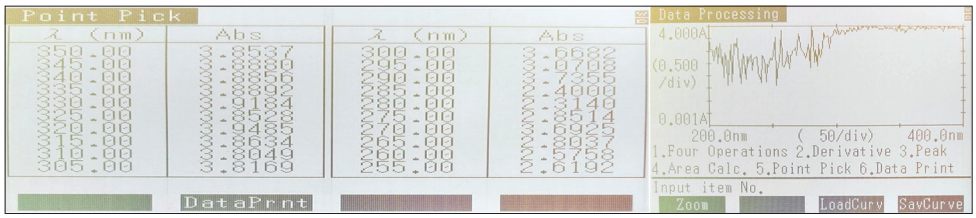

Figure 8: F2 formulation absorbance data obtained by the ultraviolet method, ranging from 290 to 320 nm

mark using methanol. Filter the solution through Whatman No. 1 filter paper and collect the filtrate by rejecting the first few mL of the filtrate. Take 5 mL of the aliquot in a 50 mL volumetric flask and make up to the mark using methanol. Then take 5 mL of the diluted solution into the 25 mL volumetric flask and make up to the mark using methanol. The absorption spectra of the sample solution were obtained in the range of 250–400 nm using a 1 cm quartz cell, and methanol as a blank. The absorption data were obtained in the range of 290–320, every 5 nm, and 3 determinations were made for each sample. The SPF of the samples was calculated using the equation below (a mathematical expression derived by Mansur).

$$SPF\ (spectrophotometric) = CF \times \sum (\lambda)\ 320\ 290 \times (\lambda) \times A(\lambda)$$

Where, CF is the correction factor (=10);
EE (λ) - erythemal effect of radiation with wavelength λ. The Determination of pH, skin irritation test, and Spreadability test and Viscosity was shown in Figure 2-6.

RESULTS AND DISCUSSION

The novel research work was made to prepare the sunscreen cream using ingredients such as zinc oxide, raspberry oil, jojoba oil, shea butter, liquid paraffin, tween 80, glycerin, rose oil, Carbopol, by various combinations. The prepared sunscreen cream was evaluated for physical appearance, pH, skin irritation, perfume stability, spreadability, viscosity, and SPF.

Physical appearance

The formulations of sunscreen cream prepared appeared in white color [Table 2].

Table 2: Evaluation of formulation for physical appearance, Odor, and pH

S. No.	Formulation	Physical appearance	Odour	pH
1.	F1	White color	Pleasant	6.3
2.	F2	White color	Pleasant	6.2
3.	F3	White color	Pleasant	6.3
4.	F4	White color	Pleasant	6.4
5.	F5	White color	Pleasant	6.3
6.	F6	White color	Pleasant	7.0

Table 3: Evaluation of viscosity for prepared formulations

S. No.	Formulation	Viscosity (cps)	Spreadability
1.	F1	5020	Average
2.	F2	5035	Average
3.	F3	6618	Good
4.	F4	6918	Good
5.	F5	7208	Good
6.	F6	8912	Very good

Determination of pH

The pH of the formulated sunscreen cream was determined and found to be in the range of 6.2–7.0 [Table 2].

Skin irritation

All the prepared formulations of sunscreen cream did not show any skin irritation when applied on the skin and observed for more than 10 min [Table 2].

Table 4: Absorbance data from 290 to 320 obtained by the ultraviolet method, and calculation of SPF for all the formulations, ranging from F1 to F6, and also represents the grades of all the formulations

S. No.	Wavelength	EE×I	Formulation F1		Formulation F2	
			Absorbance	EE×I×A	Absorbance	EE×I×A
1.	290	0.015	3.3469	0.0502035	3.7355	0.0560325
2.	295	0.0817	3.4683	0.28336011	3.0708	0.250888
3.	300	0.2874	3.7656	1.08223344	3.6682	1.054240
4.	305	0.3278	3.8699	1.26855	3.8169	1.2511798
5.	310	0.1864	3.7387	0.696893	3.8049	0.709233
6.	315	0.0839	3.7415	0.31391185	3.8634	0.324139
7.	320	0.018	3.9451	0.0710118	3.9485	0.071073
			Total	3.511139	Total	3.71677
S. No.	**Wavelength**	**EE×I**	**Formulation F3**		**Formulation F4**	
			Absorbance	**EE×I×A**	**Absorbance**	**EE×I×A**
1.	290	0.015	3.5499	0.0532485	3.1654	0.047481
2.	295	0.0817	3.7462	0.30606454	3.4946	0.2830626
3.	300	0.2874	3.6798	1.0573158	3.7793	1.08617082
4.	305	0.3278	3.6669	1.20200982	3.7390	1.2256442
5.	310	0.1864	3.8521	0.7180314	3.8354	0.71491856
6.	315	0.0839	3.8347	0.32173131	3.9052	0.32764628
7.	320	0.018	3.9194	0.0705492	3.7513	0.0675234
			Total	3.7279	Total	3.75244686
S. No.	**Wavelength**	**EE×I**	**Formulation F5**		**Formulation F6**	
			Absorbance	**EE×I×A**	**Absorbance**	**EE×I×A**
1.	290	0.015	3.2404	0.048606	3.9089	0.05863
2.	295	0.0817	3.8313	0.31301721	3.9046	0.31900582
3.	300	0.2874	3.6590	1.0515966	3.8991	1.12060134
4.	305	0.3278	3.9230	1.285959	3.8679	1.26789762
5.	310	0.1864	3.8830	0.723791	3.8414	0.71603696
6.	315	0.0839	3.9782	0.333770	3.7554	0.31507806
7.	320	0.018	3.9069	0.070324	3.7340	0.067212
			Total	3.82706381	Total	4.4639

S. No.	Formulations	SPF=CF×Σ^{320}_{290}×EE×I×absorbance	SPF values	Grade
1.	F1	3.511139×10	35.119	High protection
2.	F2	3.71677×10	37.167	High protection
3.	F3	3.7279×10	37.27	High protection
4.	F4	3.75244686×10	37.52	High protection
5.	F5	3.82706381×10	38.27	High protection
6.	F6	4.4639×10	44.679	Very high protection

SPF: Sun protection factor

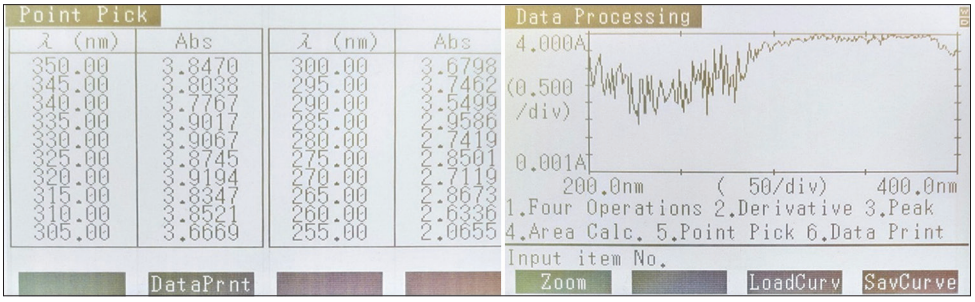

Figure 9: F3 formulation absorbance data obtained by the ultraviolet method, ranging from 290 to 320 nm

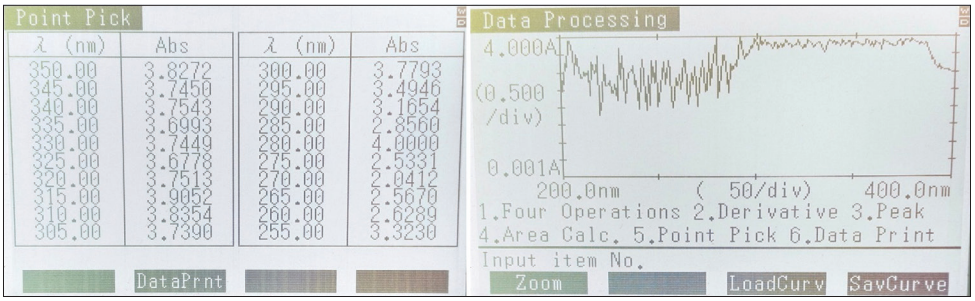

Figure 10: F4 formulation absorbance data obtained by the ultraviolet method, ranging from 290 to 320 nm

Figure 11: F5 formulation absorbance data obtained by the ultraviolet method, ranging from 290 to 320 nm

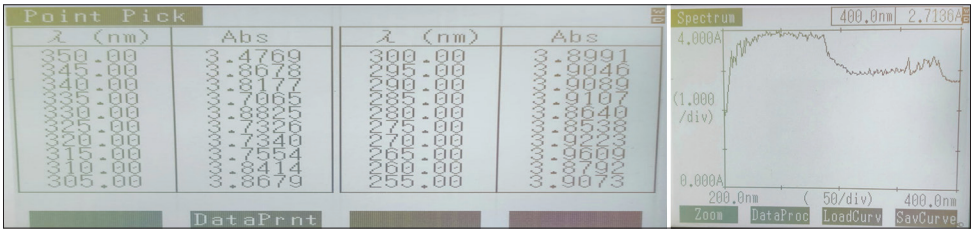

Figure 12: F6 formulation absorbance data obtained by the ultraviolet method, ranging from 290 to 320 nm

Spreadability

Formulations of sunscreen cream showed from average to very good spreadability. Formulation (F6) showed a very good spreadability nature compared to other formulations [Table 3].

Viscosity

The viscosity of sunscreen cream was determined for the formulations, and the results ranged from 5020 to 8912 cps [Table 3].

SPF

The SPF of the sunscreen cream was determined for the formulations, and the results are shown in [Table 4]. The SPF ranges from 35.11 to 44.679 [Figures 7-12].

CONCLUSION

In the present work, efforts have been made to prepare and evaluate the sunscreen cream using ingredients such as zinc oxide, raspberry oil, jojoba oil, Tween 80, shea butter, liquid paraffin, rose oil, glycerine, and methyl paraben in various combinations.

A total of six formulations of sunscreen creams were prepared, coded from F1 to F6. All the prepared formulations of sunscreen cream were evaluated for various tests, and the results obtained for all were in an acceptable range. Among all the formulations, the spreadability of the F6 formulation obtained is very good compared to other formulations. The values of pH obtained for formulation 6 are similar to skin compatibility with SPF. Among all the formulations, the SPF for F6 formulation has a very high protection grade as compared to other formulations. By considering the results of all the various performed parameters, the F6 formulation was selected as the best formulation in the present research work.

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