Formulation and Evaluation of Herbal Sunscreen

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***Abstract*—Sunlight consists of harmful ultraviolet radiation which cause sunburn, suntan and skin damage. The incorporation of herbal(natural) ingredients having property of protection of skin from harmful UV light into sunscreen cream is the most effective way. The aim of the present study was formulation and evaluation of sunscreen creams containing Carica papaya fruit extract, rhizome extract of Curcuma longa and Aloe vera extract. Dried fine powder of papaya was extracted in distilled water by maceration process. Dried powdered rhizomes of turmeric were extracted in ethanol by maceration. Three sunscreen cream were formulated and evaluated by physicochemical parameters such as color, odour, spread ability, pH, and viscosity. Sunscreens are found in cream, lotion, gel, stick, spray, and lip balm type's forms. They are for external use only. The in vitro SPF of the formulations was determined according to the UV Spectrophotometric method of Mansur et al. The presented work was planned to study the sunscreen (photoprotective) activity of herbal sunscreen which contain ethanolic extract of rhizome of Curcuma longa (turmeric), aqueous extract of pulp of fruit of Carica papaya and Aloe-vera (Aloe barbadensis) gel. However, the sunscreens (photoprotective) activity of combination of these plants has not been reported till date. This forms the basis for selection of these plants for its sunscreen activity**

***Index Terms*—Carica papaya, Curcuma longa, Aloe vera, Photoprotective, SPF, Sunscreen, Ultraviolet radiation**

I. INTRODUCTION

Herbal Sunscreen is a embrocation (lotion) or other topical product which is used to protect the skin from the sun's UV radiation, and which reduces sunburn and other skin damage, with the aim of reducing the threat of skin cancer with the help of herbes. They are also called as Herbal suntan lotion and Herbal sunblock.[1,2] Sunscreens protect the skin from harmful ultraviolet (UV) radiation and reduce the risk of sunburn, premature aging, and skin cancer. UV radiation includes UV-A, UV-B, and UV-C; UV-B and UV-A are mainly responsible for skin damage, oxidative stress, and cancer, while UV-C is filtered by the ozone layer. Sunscreen effectiveness is measured by the Sun Protection Factor (SPF), which indicates protection against UV-B rays; higher SPF means greater protection, but proper application is essential. Broad-spectrum sunscreens that protect against both UV-A and UV-B are preferred. Sunscreens alone are not sufficient—sun avoidance and protective clothing are also important. Herbal sunscreens offer advantages such as low cost and fewer side effects. An ideal sunscreen should be broad-spectrum, stable, non-toxic, non-irritant, and effective with minimal reapplication.

Active Pharmaceutical Ingredients (API) of herbal sunscreen are as follows:

Papaya (Carica papaya): This is the Active Pharmaceutical Ingredient (API) of herbal sunscreen. Papaya is used in herbal sunscreen to protect skin from the sun and to treat sunburns. Its extract protects skin from UVA and UVB rays. The enzyme papain naturally exfoliates skin, removing dead skin cells and flaky patches of skin. These papain increases collagen production. Collagen in turn responsible for skin elasticity and health. Papaya contains vitamins A, C and E and antioxidants that help moisturize, nourish skin, and slow ageing processes.[3,4]

Turmeric (Curcuma longa): This is the Active Pharmaceutical Ingredient (API) of herbal sunscreen. Turmeric that is Curcuma longa Linn. (Family: Zingiberoside) is commonly called as Haldi in Hindi, is a perennial plant having small stem with huge long leaves.[5] Its main chemical components include 5% curcumin (yellow matter), alkaloid, essential oil (5%), cupric acid (1%), turmeric oil (5-8%). Curcumin (5%) is a polyphenol which is active

substance of turmeric used in skin care products.[5] Turmeric protects skin from UV rays, sun damage and skin cancer. Turmeric's antioxidants help soothe irritable skin and protects it from free radicals. It has a calming effect on the skin. It also prevents skin from ageing, combats acne, pimples and dark spots and moisturize the skin. They are anti-inflammatory, antineoplastic, anti-proliferative and antimicrobial effects.[8,6,9] Turmeric oil has great significance in ayurvedic medicines.[5]

Aloe-vera (Aloe barbadensis): This is the Active Pharmaceutical Ingredient (API) of herbal sunscreen. It is a succulent plant species belong to family Liliaceae. Aloe vera is a natural UV inhibitor. Its hydrating softening & intense moisturizing properties nourish the skin. It has anti-inflammatory and healing properties that can help in sunburns.[6] The presented work was planned to study the sunscreen (photoprotective) activity of herbal sunscreen which contain ethanolic extract of rhizome of Curcuma longa (turmeric), aqueous extract of pulp of fruit of Carica papaya and Aloe-vera (Aloe barbadensis) gel. However, the sunscreens (photoprotective) activity of combination of these plants has not been reported till date. This forms the basis for selection of these plants for its sunscreen activity.

II. MATERIALS AND METHODS

Plant Materials: Papaya (Carica papaya) extract, Turmeric (Curcuma longa) extract, Aloe-vera (Aloe barbadensis). Other materials (Excipients): Disodium EDTA, sodium methyl paraben, triethanolamine, coconut oil, sodium propyl paraben, stearic acid, zinc oxide, Carbopol 934 or xanthan gum(base), Ceto stearyl alcohol Preparation of turmeric extract: Turmeric rhizomes were collected from the local market of Nagpur. It was cleaned, dried and grinded to make the turmeric powder. Crude turmeric extract was prepared by maceration technique. About 15 g of finely ground turmeric power was dissolved in 100 ml of 70% Alcohol. The preparation was left for 48 hours. The filtrate obtained by filtration of the mixture was stored in a closed container in a dry and cool place for further use during formulation of sunscreen.[7] Preparation of aloe vera extract: Aloe vera (Aloe barbadensis) plant leaves that were harvested from the herbal garden at Central India College of Pharmacy, Nagpur. The leaves of Aloe vera were gathered, rinsed with water and a moderate chlorine solution, and then were sliced transversely into pieces to create Aloe vera extract, the mucilaginous jelly derived from the centre (the parenchyma) of the plant leaf. The thick skin was carefully peeled off with a vegetable peeler, and the inner gel-like pulp in the leaf's centre was divided with a spoon, chopped, and homogenized in a mixer.[7] The Aloe vera gel was stored in a closed container in a dry and cool place for further use during formulation of sunscreen. Preparation of Papaya extract: Papaya (Carica papaya) fruit was collected from the local market of Nagpur. It was properly washed, peeled off, remove the seeds, cut into small pieces, dried in hot air oven at 60°C for 48 hours followed by grinding to coarse powder using a suitable mechanical grinder. 15 g of papaya powder was dissolved in distilled water and left for 2 days. After that, the mixture was passing through filtration assembly to produce filtrate. This filtrate was stored in a closed container in a dry and cool place for further use during formulation of sunscreen. The extracts of plant materials (Carica papaya, Curcuma longa and Aloe barbadensis)

Formulation of Sunscreen Step I: Weigh all the chemicals (Plant extracts and excipients). Step II: Water phase was prepared by collecting deionized water (73%) and then (5%) water was removed aside from this for final volume makeup. Water soluble components papaya extract, disodium EDTA, sodium methyl paraben and triethanolamine were dissolved in deionized water and heated till it attained warm temperature with constant stirring. Step III: Oil phase was prepared by heating ethanolic turmeric extract, coconut oil, sodium propyl paraben, stearic acid, zinc oxide, carbopol 934 or xanthan gum(base), ceto stearyl alcohol at 80°C with constant stirring. Step IV: Now, hot oil phase was mixed in hot water phase at 80°c with continuous stirring for 20-25 minutes. The aloe vera gel and rose oil was added immediately after the addition of both the phases and then continuous stirring was done until temperature has drop to 40°C and uniform emulsion is formed. The finished product has yellow colour, smooth texture and gel like consistency. It was then poured into the wide mouth container and stored at temperature not exceeding 37°C.

Composition of API and excipients of herbal sunscreen

Sr. No.	Ingredients	F1 (30ml)	F2 (60ml)	F3 (60ml)
1	Papayaextract	3ml	5ml	4ml
2	Disodium EDTA	0.006g	0.012g	0.012
3	Methyl paraben	0.09g	0.18g	0.18g
4	Triethanolamine	0.15ml	0.3ml	0.3ml
5	Cetostearyl alcohol	1.8g	3g	3g
6	Stearicacid	0.6g	1.2g	1.2g
7	Carbopol 934	-	0.3g	0.3g
8	Zincoxide	0.9g	1.8g	1.8g
9	Xanthan gum	0.15g	-	-
10	Coconut oil	3ml	3ml	3ml
11	Turmeric Extract	4ml	2drops	1drop
12	Propyl paraben	0.018g	0.036g	0.036g
13	Aloevera gel	5ml	4ml	3ml
14	Rose oil	-	0.5ml	0.5ml
15	Deionised water	21.9ml	38ml	38ml

III. EVALUATION OF HERBAL SUNSCREEN FORMULATION

1. Appearance & Homogeneity Physical parameters like colour, odour and homogeneity were examined by visual examination.[7]
2. pH: The pH of sunscreen must be in the range 6-7. 2. pH test in order to calibrate the pH metre, standard buffer solution was used. The pH of the cream, which was weighed (0.5gm) and dissolved in 50.0 ml of alcohol or distilled water, was determined.[7] The pH of sunscreen must be in the range 6-7. Determination of pH of F1, F2 and F3
3. Irritancy test: Marked a 2 square centimetre area on the left dorsal surface. After applying the cream to the designated area, the time was recorded. Irritation, erythema, and oedema were seen and reported at regular intervals for up to 12 hours.
4. Spread ability: Two glass slides with standard measurements (20 5) were chosen. On a slide, the formulation was visible. The other slide was positioned on top of the cream in such a way that the formulation was sandwiched between the two slides, spaced 7.5 cm apart, and 100 grams of weight was evenly distributed to make a thin layer. The excess cream that was sticking to the slides was scraped off after the weight was removed. Only the bottom slide was held securely by the opposing fangs of the clamps, allowing the top slide to drop off freely due to the force of the weight linked to it. The two slides were fastened to stand (at a 45° angle) without even the tiniest disruption. Weight measuring 60 grammes was properly fastened to the upper slide. The amount of time needed for the upper slide to move 5 cm and then separate from the lower slide under the influence of weight was recorded. Three repeats of the experiment were conducted, and the mean obtained for these three dimensions was determined. The outcomes were noted. Using the following formula, spread ability is determined:[7]

$S = M*L/T$

Determination of Spread ability of F1, F2 and F3

5. Viscosity: Viscosity of the sunscreen was measured using a Brookfield viscometer at 10-100 rpm, measurement was made at 25°C. Firstly, the level of viscometer was set up. Once the level of viscometer set, the device has started. The appropriate spindle (usually spindle no. 4 or 5 are used) was chosen, and then the working conditions were set up. Readings are noted at different RPM like 25, 50, 75, 100.[5] Determination of Viscosity using a Brookfield viscometer.
6. Washability: Washability test was carried out by applying a small amount of cream on the hand and then washing it with tap water.7
7. Thermal stability: In this experiment, the oil separation from the cream was examined in a humidity chamber at 60-70% relative humidity and 37-1°C. On the interior wall of the 100 ml chamber's complete heights, a cream stripe 20 mm wide and 5 mm thick was applied. The beaker was stored in a humidity chamber for 8 hours at a temperature of 37 °C and a relative

humidity of 60–70%. There should not be any oil separation in the cream for it to pass the test. The findings are displayed in a table.[7]

8. Sun Protection Factor Determination: Sample preparation: 1.0 g of sample was weighed, transferred to 100 ml volumetric flask, diluted to volume with ethanol followed by ultrasonication for 5 min and then filtered through cotton, rejecting the first 10 ml. A 5.0 ml aliquot was transferred to 50 ml volumetric flask and diluted to volume with ethanol. Then 5.0 ml of aliquot was transferred to 25 ml volumetric flask and the volume completed with ethanol. Thereafter, absorbance values of each aliquot prepared were determined from 290-320 nm at 5 nm interval, taking ethanol as a blank. The measurements were taken thrice and the determinations were made at each point, followed by application of Mansur equation. Mansur et.al (1986) developed a very simple mathematical equation which substitutes the in vitro method proposed by Sayre et al. (1979), utilizing UV Spectrophotometry and the following equation.

SPF_spectrophotometric = CF × Σ_ (λ=290 to 320) [EE(λ) × I(λ) × Abs(λ)]

Were,

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×I am constant[5]

IV. RESULTS

In this research, herbal sunscreen cream containing ethanolic extract of rhizomes of *Curcuma longa,* fruit extract of Carica papaya and Aloe vera gel were formulated and evaluated by various evaluation tests. The results of the physicochemical analysis of tested sunscreens formulations showed in Table

Table: The results of the physicochemical analysis of tested sunscreens formulations.

Sr. No.	Parameters	Observation of formulations		
		F1	F2	F3
1	Colour	Dark yellow	Light Yellow	Brightlight yellow
2	Odour	Obnoxious	Obnoxious	Pleasant
3	Homogeneity Byvisual By touch	Homogeneous. Smooth and consistent.	Homogeneous. Smooth and consistent.	Homogeneous. Smooth and consistent.
4	pH	7.03	7.17	6.92
5	Viscosity (cps) Withspindle no.4		(at 34.8°C)	(at 30°C)
	25RPM	9934	12934	10394
	50RPM	287	6287	9832
	75RPM	145	2045	7391
	100RPM	284	1284	5897
6	Spreadability	Uniform with a value of 32 g.cm/sec.	Uniform with a value of 40 g.cm/sec.	Uniform with a value of 45 g.cm/sec.
7	Irritancy	No irritation reaction persists	No irritation reaction persists	No irritation reaction persists
8	Washability	Easily washable	Easily washable	Easily washable
9	Thermalstability	No oil separation	No oil separation	No oil separation
10	SPF determination	-	-	SPF=46.87

Stability testing under high humidity showed no phase separation, confirming the formulation's stability under stress conditions. Spread ability and viscosity, which affect cosmetic acceptability, were evaluated; viscosity decreased with increased rotation speed, indicating pseudoplastic behavior. This flow property helps form a uniform protective film on the skin, improving adherence. UV spectrophotometric analysis of formulation F3 (290–320 nm) showed effective UV absorption, and its SPF was found to be 46.87, indicating very high sun protection

Table: Absorbance of UV light by Formulation (F3) of herbal sunscreen at different wavelengths from 290-320 nm using UV Spectrophotometer

Sr.No.	Wavelength(nm)	Absorbance of UV light by Formulation (F3) of herbal sunscreen
1	290(ʎmax)	7.898
2	295	6.879
3	300	5.897
4	305	4.589
5	310	3.156
6	315	2.348
7	320	1.2415

V. DISCUSSION

The F3 formulation was selected after the physicochemical evaluation. The herbal sunscreen cream F3 was smooth, non-greasy and homogenous with a bright yellow colour. The F3 formulation has odour. The pH is excellent for skin and it didn't produce any irritation, inflammation or redness. The viscosity of the creams indicates good rheology while handling. Thermal stability studies proves that there is no separation of phase occurred in the given temperature and humidity conditions. Absorbance of UV light by Formulation (F3) of herbal sunscreen was decreased from wavelengths 290-320 nm. The Graph of Absorbance of UV light by formulation (F3) of herbal sunscreen at different wavelengths from 290-320 nm using UV Spectrophotometer shown in fig. 19 that decrease in the absorbance of UV radiation after application of formulation (F3) of herbal sunscreen.

VI. CONCLUSION

From the result obtained in the study we can positively conclude that Carica papaya, Curcuma longa and Aloe barbadensis sunscreens have significant UV absorbing property. This will be a better, cheaper and safe alternative to harmful chemical sunscreens that used now days in the industry. The Graph of Absorbance of UV light by formulation (F3) of herbal sunscreen at different wavelengths from 290-320 nm using UV Spectrophotometer that decrease in the absorbance of UV radiation after application of formulation (F3) of herbal sunscreen. SPF of prepared sunscreen (F3) was found to be 46.87 which means the formulated sunscreen have good photoprotective property.

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