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Research Article

Formulation and Evaluation of Herbal Sunscreen Lotion

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ABSTRACT

Sunscreens are topical preparations intended to shield the skin from the damaging effects of ultraviolet (UV) rays, especially UV-A and UV-B radiation, which lead to sunburn, premature aging, and even skin cancer. While traditional sunscreens usually contain synthetic chemicals that might result in skin irritation or ecological damage, herbal sunscreens provide a natural and safer option. Herbal sunscreens are prepared from plant-derived ingredients that have natural UV-blocking, antioxidant, anti-inflammatory, and skin-soothing properties. This study involves the development and assessment of a herbal sun lotion. The initial objective was to develop a natural, skin-friendly sunscreen product with the help of herbal extracts that have photoprotective and antioxidant effects. The major ingredients employed were Litchi, Tulsi, Green Tea, Aloe Vera, Neem, Sandalwood, Cucumber, and Liquorice. Formulation was carried out by preparing the lotion as an emulsion type and ensuring proper consistency and stability. Preliminary phytochemical screening confirmed the presence of useful compounds such as flavonoids, saponins, glycosides, tannins, and phenols, in higher content in aqueous extracts. Physicochemical parameters such as ash value, extractive value, and moisture content were determined and found within acceptable ranges. Three formulations (F1, F2, F3) were analyzed for organoleptic properties, pH, homogeneity, spreadability, and washability. Sun Protection Factor (SPF) was established using spectrophotometric analysis and showed that the highest UV protection was given by formulation F3. The study generally concludes that the herbal sunscreen lotion provides sun protection, thereby identifying the cosmetic potential of herbal ingredients.

INTRODUCTION

Sunscreens are topical agents used to protect the skin from the harmful effects of ultraviolet (UV) radiation. These formulations work by either reflecting, scattering, or absorbing UV-A and UV-B rays, which are known to cause photoaging, sunburn, and an increased risk of skin cancer. Regular use of sunscreen helps prevent premature skin aging and reduces the incidence of various

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UV-induced dermatological disorders. UV radiation is typically divided into three types: UV-A (320–400 nm), UV-B (290–320 nm), and UV-C (100–290 nm). While UV-C is mostly absorbed by the Earth's atmosphere, UV-A and UV-B reach the skin and contribute to different forms of damage. UV-A penetrates deeper, causing long-term effects like aging and DNA damage, whereas UV-B is responsible for more acute issues such as sunburn and blistering.To address this, sunscreens are formulated using active ingredients that function as either physical blockers or chemical absorbers. Physical blockers, like zinc oxide and titanium dioxide, remain on the surface of the skin and reflect UV rays. Chemical absorbers, on the other hand, penetrate the skin and absorb UV radiation, converting it into less harmful energy. Many modern sunscreen products combine both types to achieve broad-spectrum protection. The effectiveness of a sunscreen is typically measured by its Sun Protection Factor (SPF), which indicates the level of protection it offers against UV-B rays. A higher SPF value corresponds to greater protection. However, SPF does not directly correlate with the time a person can spend in the sun without burning; rather, it measures the comparative increase in exposure time required to cause sunburn when using the sunscreen versus without it. In recent years, there has been growing concern over the safety and environmental impact of synthetic sunscreen agents. Compounds like oxybenzone and avobenzone, although effective, have been associated with skin irritation and potential hormonal effects. Furthermore, their accumulation in water bodies has raised environmental alarms, particularly concerning coral reef damage. As a result, the focus has shifted towards naturally derived, plant-based alternatives. Herbal and botanical ingredients offer a safer and more sustainable approach to photoprotection. Many medicinal plants are rich in flavonoids, phenolic acids, and antioxidants that absorb UV radiation and neutralize free radicals. These phytoconstituents are not only effective in minimizing sun damage but also contribute to overall skin health through anti-inflammatory and moisturizing actions. Polyherbal formulations, which combine multiple herbal extracts, are widely used in traditional medicine systems for their synergistic effects. In the context of sunscreens, combining extracts such as Aloe vera, Green tea, Tulsi, Neem, Sandalwood, Litchi, Cucumber, and Liquorice allows for broader protective coverage while enhancing the formulation's stability and cosmetic acceptability. This project is aimed at formulating and evaluating a herbal sunscreen lotion using a combination of plant-based extracts known for their UV-absorbing and antioxidant properties. The study includes preparation of the formulation, analysis of physicochemical properties (such as pH, viscosity, spreadability), and SPF evaluation using UV spectrophotometry. The goal is to develop a safe, effective, and eco-friendly alternative to chemical sunscreens that meets current demands for natural skincare solutions

MATERIALS AND METHODS

List of Materials, Chemicals and Equipments

Table no:1 Plant materials used for the development of formulation

Sr. No	Botanical name	Vernacular name	Source
1	Litchi chinensis	Litchi	Indoor vendors
2	Ocimum sanctum	Tulsi	Indoor vendors
3	Aloe barbadenis	Aloe vera	Indoor vendors
4	Camellia sinensis	Green tea	Indoor vendors
5	Santalum album	Sandalwood	Indoor vendors
6	Cucumis sativus	Cucumber	Indoor vendors

7	Glycyrrhiza glabra	Liquorice	Indoor vendors
8	Azadirachta indica	Neem	Indoor vendors
9	Helianthus annus	Sunflower oil	Indoor vendors

Table no: 2 Chemical ingredients used for the development of formulation

Sr. No.	Materials/ Solvents	Suppliers/ Manufacturers
1	Beeswax	Numex chemical products India Ltd
2	Cetostearyl alcohol	Burgoyne burbidges

Table no: 3 Equipments used for the formulation

Sr. No	Equipments	Suppliers/ Manufacturers
1	Digital weighing balance	Universal agencies
2	Digital pH meter	Universal agencies
3	Compound microscope	Pentac solutions
4	Muffle furnace	Universal agencies
5	Hot air oven	Pentac solutions
6	Spectrophotometer	Pentac solutions

METHODS

PHYSICOCHEMICAL STUDY OF THE PLANT MATERIALS

Determination of ash value

The ash value is an important parameter for the evaluation of the crude drugs. The following different methods are adopted.

- Total ash
- Acid insoluble ash
- Water soluble ash

Determination of moisture content

Weigh accurately 3g of powdered drug and transfer it into a tared Petri dish. Then the crude drugs were heated at 105c in an oven till constant weight was obtained. Percentage moisture content of the sample was calculated with the reference to the air-dried drug.

Moisture content (%) = Initial weight of sample-Final weight of sample/Initial weight of sample X 100

PREPARATION OF PLANT EXTRACT

Aqueous extraction of collected material is done by Maceration.

Steps Involved

- 20g of powder is mixed with 200ml water in a glass jar.
- Cover the jar with a lid and let it sit in cool & dark room.
- Shake the jar to facilitate extraction.
- After maceration, strain the mixture through cheese cloth or a clean cotton cloth into a collection container. Discard the solids.
- Filter the liquid extract through a filter paper to remove any impurities.
- Collect the aqueous extract.

PRELIMINARY PHYTOCHEMICAL STUDY

The extracts were subjected to preliminary phytochemical screening to detect the various phytoconstituents such as Alkaloids, Flavonoids, Tannins, Saponin, Phenol, Glycosides, Proteins and Carbohydrates

FORMULATION OF THE HERBAL SUNSCREEN LOTION

Table no: 4 Formulation of herbal sunscreen

Sr. No	Ingredients	F1	F2	F3
1	Aloe vera extract	5g	7g	10g
2	Green tea extract	3g	5g	7g
3	Tulsi extract	2g	3g	5g
4	Litchi extract	2g	3g	5g

5	Sandalwood extract	1g	2g	3g
6	Neem extract	2g	3g	4g
7	Cucumber extract	2g	3g	5g
8	Liquorice extract	1g	2g	3g
9	Beeswax	3g	3g	3g
10	Cetostearyl alcohol	2ml	2ml	2ml
11	Sunflower oil	5ml	5ml	5ml
12	Perfume	Q.S.	Q.S.	Q.S.
13	Distilled water	Upto 100ml	Upto 100ml	Upto 100ml

Procedure

- Distilled water was heated to approximately 70° C and measured quantities of herbal extracts were added and stirred until fully dissolved.
- Beeswax, cetostearyl alcohol and sunflower oil were melted together by heating to 70° C with continuous stirring.
- The hot aqueous phase was slowly added to the oil phase with constant stirring.
- The lotion was allowed to cool to room temperature and a small quantity of perfume was added.
- Distilled water was added to make up the weight.

EVALUATION OF HERBAL SUNSCREEN LOTION

Organoleptic Evaluation

Formulation prepared was evaluated for the clarity, colour, odour, and foam producing ability.

Determination of pH

The pH of sunscreens was determined using a digital pH meter. pH was measured after 1 g of the formulation was dissolved in 100 ml of newly prepared distilled water for 2 hours. The purpose of this study was to guarantee that the pH of the produced herbal sunscreens is similar to the pH of the skin after 24 hours of use.

Test for homogeneity

A small amount of the sunscreen lotion is placed on a glass slide. The lotion is carefully spread into a thin, even layer on the slide. A cover glass is placed on top. The slide is then observed under a microscope. The lotion is visually examined for any visible particles, clumps, or uneven distribution. If the lotion appears uniform with no visible coarse particles, it's considered homogeneous.

Washability test

Apply a small amount of the sunscreen lotion to the fingertip. Gently rub the lotion-covered fingertip with water. Note how easily the lotion washes off and if any residue remains.

Spreadabilty test

A known weight of the sunscreen lotion is placed on a glass surface. Another glass surface is placed on top, and a weight is added. After a specific time, the diameter of the spread is measured.

Determination of SPF

SPF value is determined in vitro using a spectrophotometer. 0.0125 grams of each preparation sample was taken and then diluted with 70% ethanol to 50 ml. The 70% ethanol solution was used as a blank. The absorbance results of the sample at a wavelength of 290 - 320 and an interval of 5 nm were recorded, and then the SPF value was calculated. The SPF value was calculated using the Mansur method;

$$SPF = CF \times \sum EE(\lambda) \times I(\lambda) \times Abs(\lambda)$$

Description:
CF: Correction Factor (10)

EE: Spectrum of effects of erythema

I: Solar intensity spectrum

Abs: Sample absorbance

RESULTS AND DISCUSSION

Table no:5 Results of physicochemical study

Sr. No	Sample	Total Ash Value (% w/w)	Water Soluble Extractive Value (%w/w)	Percentage Loss on Drying (% w/w)
1	Green Tea	6%	7.6%	3.15%
2	Cucumber	1.36%	21%	8.19%
3	Neem	10.34%	4.6%	10.53%
4	Sandalwood	23.65%	2.8%	5.63%
5	Litchi	0.64%	17%	6.39%
6	Liquorice	5.67%	6.2%	7.64%
7	Tulsi	13.67%	6.6%	6.38%
8	Aloe Vera	12.46%	9%	11.79%

Figure 9: Determination of ash value

Figure 10 &11: Extraction of plant materials

PRELIMINARY PHYTOCHEMICAL STUDY

Table no:6 Results of Preliminary phytochemical study of aqueous extract

	Green tea	Cucumber	Neem	Sandalwood	Litchi	Liquorice	Tulsi	Aloe vera
Alkaloids	++	-	++	-	-	+	+	-
Flavonoids	++	++	+	++	+++	+	+	++
Tannins	+	+	+++	+	++	++	++	+
Saponin	+	+	+	+	+	+	+	++
Phenol	+++	++	++	++	++	+	+++	++
Glycosides	+	+	+	-	+	++	+	-
Proteins	+	-	+	-	-	-	+	+
Carbohydrates	-	+	+	+	+	+	+	+

[+: mild, ++: moderate, +++: intense, -: negative]

Table no: 7 Results of preliminary phytochemical study of alcoholic extract

	Green tea	Cucumber	Neem	Sandalwood	Litchi	Liquorice	Tulsi	Aloe vera
Alkaloids	+	-	+	-	-	-	+	-
Flavonoids	+	+	+	+	++	+	-	+
Tannins	+	+	-	+	+	+	+	+
Saponin	+	+	+	-	+	+	+	+
Phenol	++	+	++	+	+	-	+	++
Glycosides	-	-	+	-	-	+	+	-
Proteins	-	-	-	-	-	-	+	+
Carbohydrates	-	+	-	+	+	+	-	-

[+: mild, ++: moderate, +++: intense, -: negative]

Table no: 8 Results of preliminary phytochemical study of chloroform extract

	Green tea	Cucumber	Neem	Sandalwood	Litchi	Liquorice	Tulsi	Aloe vera
Alkaloids	+	-	+	-	++	-	+	+
Flavonoids	+	+	+	-	+	+	-	+
Tannins	-	-	-	-	-	+	-	++
Saponin	-	+	-	-	+	-	-	+
Phenol	++	+	+	+	+	+	+	+
Glycosides	-	-	+	-	-	+	+	-
Proteins	+	-	+	-	-	-	+	-
Carbohydrates	-	-	+	-	+	+	+	-

[+: mild, ++: moderate, +++: intense, -: negative]

EVALUATION OF HERBAL SUNSCREEN LOTION

Table no:9 Evaluation of herbal sunscreen lotion

Sr. No	Parameters	Formulation		
		F1	**F2**	**F3**
1	State	Liquid	Liquid	Liquid
2	Colour	Pale Green	Pale Green	Pale Green
3	Odour	Characteristic	Characteristic	Characteristic
4	Texture	Smooth	Smooth	Smooth
5	pH	7.05	6.97	7.18
6	Homogeneity	Good	Good	Good
7	Washability	Good	Good	Good
8	Spreadability	6.5	5.8	7.2

Table no: 10 Results of determination of SPF

Wavelength	EE×I	F1		F2		F3	
		Abs	**EE×I×Abs**	**Abs**	**EE×I×Abs**	**Abs**	**EE×I×Abs**
290	0.015	1.843	0.0276	1.396	0.0209	2.015	0.0302
295	0.0817	1.636	0.1336	1.582	0.1292	2.594	0.2119
300	0.2874	0.893	0.2556	1.713	0.4923	2.839	0.8159
305	0.3274	1.568	0.5139	1.863	0.6101	3.103	1.0171
310	0.1864	0.956	0.0177	1.792	0.3340	4.739	0.1881
315	0.0834	1.198	0.1002	1.785	0.1488	2.995	0.2497
320	0.0180	1.235	0.0222	1.613	0.0290	1.973	0.0355
		Total:1.0708		**Total:1.7643**		**Total:2.4484**	

		SPF:10.708	**SPF:17.643**	**SPF:24.484**

DISCUSSIONS:

The ultimate aim of the present work was to formulate and evaluate herbal sunscreen lotion. The study was targeted to prepare a natural and dermatologically friendly sunscreen formulation by incorporating herbal components recognized for their photoprotective, antioxidant, and calming attributes. The preparation comprised a synergistic mixture of the following herbal compounds such as Litchi, Tulsi, Green tea, Aloe vera, Neem, Sandalwood, Cucumber, Liquorice. The formulation process involved creating an emulsion-based lotion with these herbal extracts, ensuring optimal consistency, stability, and skin compatibility. Preliminary screening of phytochemicals of the chosen plants was conducted in alcohol, chloroform and water and the result indicated the presence of phytoconstituents including flavonoids, saponins, glycosides, tannins and phenols. The preliminary phytochemical screening of the herbal sunscreen cream indicated a greater content of phytochemicals in aqueous extraction as compared to alcohol and chloroform. The physicochemical parameters like ash value, extractive value, moisture content was estimated and all the results were within the acceptable limit. The herbal sunscreen lotion was formulated based on 3 formulae (F1, F2, F3) and evaluation was carried out. The organoleptic characteristics, pH, homogeneity, spreadability and washability were also performed. The Sun Protection Factor (SPF) was determined using spectrophotometric analysis across the UV-B range (290–320 nm) on all formulations, and the results indicate that Formulation F3 has the highest sun protection efficacy, followed by F2 and F1. In conclusion the SPF values suggest that the formulation F3 offers the most effective UV protection.

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